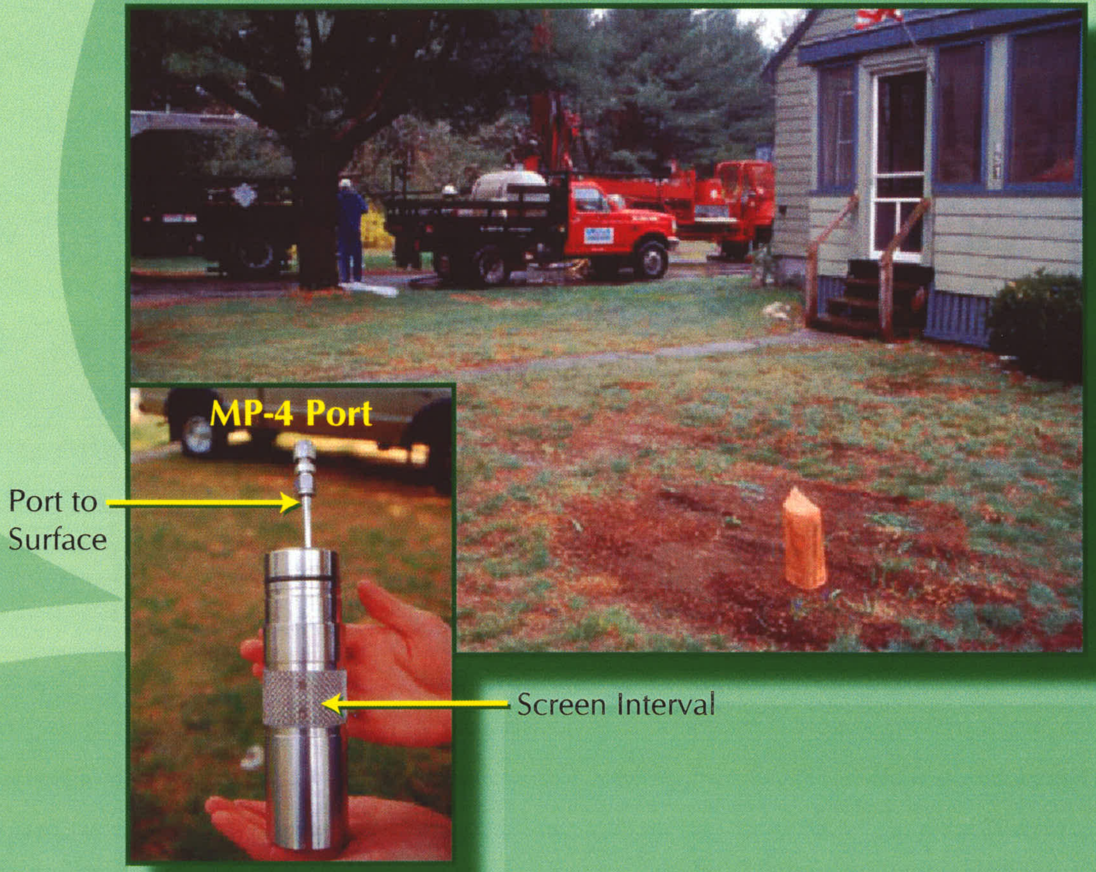
Olin Wilmington Technical Series

XVII. The Main Street Bedrock Saddle Investigations



Prepared for:

Olin Corporation
Wilmington, MA Facility

December 19, 2001

geomega

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THE MAIN STREET BEDROCK SADDLE INVESTIGATIONS

December 19, 2001

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Executive Summary

EXECUTIVE SUMMARY

The 51 Eames Street property in Wilmington, Massachusetts is a former chemical manufacturing facility that has been owned and operated by various companies since the early 1950s. Historic disposal practices at the facility have resulted in the transport of chemical compounds in groundwater from the Property to the west. Groundwater west of the Property is located within the Maple Meadow Brook Aquifer (MMBA), a water resource area for the town of Wilmington. The area affected by historical releases at the Property is listed by the Massachusetts Department of Environmental Protection (MADEP) as a Tier 1A Disposal Site (Release Tracking Number 3-0471). The Property is currently owned by Olin Corporation (Olin), which is responsible for actions at the Site under the provisions of the Massachusetts Contingency Plan, 310 CMR 40.0000.

This report presents the results of an investigation to assess the existence of a physical (geologic) feature that constrains westward migration of dense aqueous-phase liquid (DAPL) in groundwater. Based on the information described herein, it is Geomega’s conclusion that the feature consists of a subsurface ridge of bedrock, referred to as the "Main Street Saddle," which protrudes into the unconsolidated overburden aquifer and acts as a dam preventing downgradient flow of DAPL along the top-of-bedrock surface into the so called “Western Bedrock Valley” (WBV) within MMBA. The report summarizes pertinent results of previous studies indicating the existence of the Main Street Saddle, describes additional borings performed to fully delineate the saddle's location and elevation, and presents results of downhole testing and multilevel piezometer installation and sampling at the saddle's low point. Collectively, the various elements of this investigation and other ancillary data provide a basis for explaining the current distribution of DAPL and assessing its potential for future westward migration within the MMBA, which is discussed in the final part of the report.

As part of the present study, three additional borings were advanced to bedrock in the vicinity of the saddle to more accurately delineate the lowest point of the saddle. The exploratory drilling was performed by first driving a perforated well point that allowed collection of groundwater samples at specific depths beneath the surface, and then subsequently using Rotosonic (vibratory/rotary) drilling to enlarge the boring and collect continuous soil samples from the surface to refusal in bedrock. On the basis of the additional depth-to-bedrock information from these borings, the location of the lowest point of the saddle was selected for bedrock coring and the installation of the new multilevel piezometer, referred to as MP-4.

Based on the depths to bedrock in all of the Main Street borings, the available seismic data, and information from local monitoring wells, the bedrock saddle was determined to be an elongated ridge aligned approximately parallel to and just west of Main Street. The lowest point of the saddle, at the northern end of the bedrock ridge, was found to be at an elevation of approximately 32 feet above mean sea level.

Downhole testing—consisting of hydraulic packer tests, Borehole Image Processing System (BIPS) logging, and hydrophysical logging—was performed in the bedrock portion of the boring at the saddle's low point to determine fracture density and orientation and the hydraulic conductivity of transmissive fracture zones. These tests were also performed in open sections of monitoring wells GW-62BR and GW-62BRD to establish comparative data for adjacent areas in the WBV.

MP-4 was built from 2-inch diameter PVC casing with fourteen 6-inch stainless steel sampling ports. The depths of the sampling ports for MP-4 were based on the results of the hydrophysical and BIPS logging and visual inspection of the core.

Water-quality data from MP-4 and ancillary data from other investigations support the finding that Main Street Saddle appears to be functioning as an effective barrier to downgradient DAPL migration. Intermediate locations between MP-4 and GW-83D in the WBV have much lower concentrations of DAPL-indicator parameters than either the Main Street Saddle or WBV areas, demonstrating that the DAPL-related solutes observed in the MP-4 fractures are not being transported through bedrock to the WBV. Instead, historical overtopping of the Main Street Saddle is thought to have resulted in DAPL flow down the bedrock channel between GW-58D and GW-62 toward the WBV and produced the remnant pools of concentrated liquids that remain trapped in bedrock surface depressions in the WBV.

Bedrock of the Main Street Saddle contains numerous fractures, most of which are calcite filled. In situ testing showed that groundwater flow does occur in a few fracture zones within bedrock, however those fracture zones have a relatively low overall effective transmissivity. Additionally, the predominant fracture orientation in the Main Street Saddle is such that most of the bedrock fractures would not be expected to intersect the WBV, even if they were continuous throughout the intervening distance. Thus, the bedrock fracture data indicate that there is little, if any, potential for migration of DAPL through bedrock.

It is significant that the top-of-DAPL elevation of the lower pool is observed to be very close to the elevation of the Main Street Saddle (within the measurement uncertainties). Disposal of liquid wastes to unlined pits and ponds at the Property ceased in 1971, and there have been no additions to the DAPL since that time. Thus, the bedrock depression east of the Main Street Saddle has apparently remained filled with DAPL for the last 30 years. Also, Olin has not observed decreases in top-of-DAPL elevations since it began monitoring in 1992. The fact that the top-of-DAPL elevation of the lower pool is still at approximately the overflow elevation of the saddle crest even after 30 years indicates that there has been no substantial loss of DAPL via migration through bedrock fractures; otherwise, the top-of-DAPL would now be lower than the saddle crest.

On the basis of information presented in this report and in previous Phase II reports, it is Geomega's opinion that, as the DAPL historically migrated into the WBV and came to rest in bedrock depressions, the total mass of acidity and metals content of the DAPL dramatically decreased due to reactions with surrounding groundwater and aquifer materials. These processes are probably still continuing to some extent as ambient groundwater flows over the surface of the remnant DAPL and provides alkalinity to neutralize and precipitate DAPL constituents in the aquifer. The reactions cause a chromium-bearing mineral phase to be precipitated, thereby occluding primary aquifer porosity and filling bedrock fractures. In turn, the occlusion of aquifer porosity and fracture filling caused by mineral precipitation would be expected to reduce the effective hydraulic conductivity of both overburden and fractured bedrock in contact with the

DAPL, and thereby limit the diffusive flux of constituents from the DAPL into overlying groundwater.

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Section 1

1 INTRODUCTION

The 51 Eames Street property in Wilmington, Massachusetts (the Property) is a former chemical manufacturing facility that has been owned and operated by various companies since the early 1950s. Historic disposal practices at the facility have resulted in the transport of chemical compounds in groundwater from the Property to the west. Groundwater west of the Property is located within the Maple Meadow Brook Aquifer (MMBA), a water resource area for the town of Wilmington. The area affected by historical releases at the Property is listed by the Massachusetts Department of Environmental Protection (MADEP) as a Tier 1A Disposal Site (Release Tracking Number 3-0471). The Property is currently owned by Olin Corporation (Olin), which is responsible for actions at the Site under the provisions of the Massachusetts Contingency Plan, 310 CMR 40.0000. The 51 Eames Street Property and the current Olin Site boundary, as identified in the *Supplemental Phase II Report* (Smith 1997), are shown in relation to the surrounding area on Figure 1.

Investigations of groundwater at the Olin Site have indicated the presence of a dense, aqueous-phase liquid (DAPL) containing more than 100,000 milligrams per liter (mg/l) of total dissolved solids (TDS)[1]. The dense liquid has migrated via density-dependent flow mechanisms through the groundwater flow system, to the west along the top of the bedrock surface, and into the MMBA (CRA 1993; Smith 1997). The current extent of DAPL has been determined on the basis of a variety of field data—including terrain conductivity mapping, downhole induction logging, specific conductivity profiling, and water quality sampling of monitoring wells and multilevel piezometers—and detailed statistical analyses of those data (Geomega 1999a, 2000a; Smith 1997). Collectively, the available data indicate that the extent of off-Property DAPL is limited to an area extending west from the Property to approximately Main Street (Figure 2).

[1] A geochemical definition of DAPL is presented in Geomega (1999a).

This report presents the results of an investigation performed on behalf of Olin to assess the potential existence of a physical (geologic) feature that constrains westward migration of DAPL. This feature is referred to as the “Main Street Saddle.” The report summarizes pertinent results of previous studies supporting the existence of the Main Street Saddle, describes additional borings performed to fully delineate the saddle’s location and elevation, and presents results of downhole testing and multilevel piezometer installation and sampling at the saddle’s low point. Collectively, the various elements of this investigation and other ancillary data provide a basis for explaining the current distribution of DAPL and assessing its potential for future westward migration within the MMBA, which is discussed in the final part of the report.

1.1 Background

1.1.1 Location and Hydrogeologic Setting

The Maple Meadow Brook Aquifer lies at the headwaters of the Ipswich River Basin in the southern part of the Town of Wilmington. Figure 1 shows the mapped Zone II of the town’s water-supply wells, which delimits the extent of the aquifer(s) contributing water to the town’s wells under the most severe pumping and recharge conditions that can realistically be anticipated (as approved by the MADEP Division of Water Supply pursuant to 310 CMR 22.00). The MMBA forms the southern part of the mapped Zone II and includes an area formerly used as a municipal landfill and also the western portion of the Olin Site.

The MMBA consists of unconsolidated glacial sand and gravel deposits that overlie crystalline metamorphic and igneous bedrock (Castle 1959). Bedrock outcrops locally interrupt the aquifer, while bedrock valleys allow the aquifer to attain an appreciable thickness in some areas. The unconsolidated sand and gravel deposits typically have a high porosity and permeability and are thus able to transmit large quantities of water, providing a highly productive aquifer. In contrast to the high permeability of the overburden material, the underlying bedrock has a much lower permeability. Because of its low primary porosity, the majority of groundwater flow in bedrock takes place through fractures, which occupy only a small percentage of the bedrock volume. Consequently, the bedrock formation is a relatively insignificant part of the overall groundwater flow system.

More detailed discussions of the hydrogeology of the Site and surrounding area are presented in Baker et al. (1964), CRA (1993), Geomega (2001), IEP (1990), and Smith (1997).

1.1.2 Bedrock Surface

The bedrock surface beneath MMBA is highly irregular, with a maximum relief of approximately 120 feet. Contours of the top-of-bedrock surface have been developed from outcrops, borings, seismic refraction profiles, and seismic reflection profiles (Figure 3). The primary feature of the bedrock surface west of Main Street is a deeply incised channel known as the Western Bedrock Valley (WBV).

Depressions in the bedrock surface are potential reservoir basins for remnants of the high-concentration liquids that were historically released at the 51 Eames Street Property and subsequently migrated into the MMBA. Because high-concentration liquids are denser than ambient groundwater they preferentially sink to the bottom of the aquifer and tend to pool in bedrock depressions. Other releases within the MMBA watershed having sufficiently high TDS concentrations, but distinct from the Property, would also be expected to migrate to low-lying parts of the bedrock surface and result in elevated solute concentrations in bedrock depressions at the base of MMBA.

1.1.3 Dense Aqueous Phase Liquid (DAPL) Characteristics

The present-day DAPL resides in localized depressions on top of the low-permeability bedrock surface at the base of the sand and gravel aquifer. The DAPL is characterized by low pH (< 4), high specific conductivity (> 20,600 µmohs/cm), and a specific gravity of at least 1.025 g/cm^3 (Geomega 1999a). The major DAPL constituents are ammonia, chloride, sodium, and sulfate. Of the inorganic constituents present within the DAPL, sulfate is detected at the highest concentrations. Recent groundwater samples of the existing DAPL indicate maximum concentrations of approximately 125,000 mg/l for the combination of the four major DAPL constituents. Maximum concentrations of other

DAPL constituents, such as chromium, are typically two or three orders of magnitude lower than that amount (cf. Geomega 1999a, Table 1).

1.1.4 Conceptual Model of Historical DAPL Migration and Fate

Liquid wastes with high concentrations of dissolved solids and low pH that gave rise to the DAPL were historically discharged between 1953 and 1971 to unlined pits and ponds on the Property. Because these pits and ponds were unlined and the underlying soil was reasonably permeable, much of the liquid waste infiltrated into the subsurface. The bottoms of the pits and ponds were either in direct contact with the water table or within a few feet of the groundwater surface. Hence, liquid wastes discharged into the unlined pits and ponds rapidly entered the groundwater system.

Owing to its high density compared with ambient groundwater, the liquid wastes tended to sink through the groundwater until they reached the low permeability bedrock surface. At that point, the bulk movement of the DAPL was controlled primarily by the shape of the bedrock surface and local permeability contrasts within the unconsolidated glacial deposits, rather than by regional hydraulic gradients. Once the DAPL reached the bedrock surface, it continued to flow down-slope along the top of the bedrock under the influence of gravity. When bedrock depressions filled, DAPL overtopped the depressions and continued to flow to other areas and bedrock depressions (Figure 4). This process led to the creation of the DAPL plume at the base of the aquifer in the vicinity of the Property (shown in plan view on Figure 2).

Currently, low concentrations of DAPL constituents are present in groundwater above the pooled DAPL as a result of the continuous process of diffusion (Smith 1997). The plume of “diffuse” DAPL constituents extends over a larger area than the existing DAPL footprint shown on Figure 2 because it is considerably less dense than the DAPL, and thus is more easily transported by the ambient groundwater flow system. The existence of the diffuse plume is evidence of an on-going natural attenuation process that gradually reduces the concentrations of DAPL solutes by transferring chemical mass into the overlying groundwater and thereby diminishes the extent and distribution of DAPL with time. Evidence of natural attenuation of DAPL also was provided by a recent analysis of water quality data from wells screened within and proximal to the on-Property DAPL, which revealed statistically significant decreasing trends in DAPL-constituent concentrations over a period of several years (Geomega 2000b).

1.2 Purpose and Scope

The *Supplemental Phase II Report* (Smith 1997) inferred that there was a subsurface geologic barrier to DAPL flow located just west of Main Street. To help resolve whether or not such a feature exists, additional seismic investigations were proposed by Olin and approved by MADEP in 1998 (Appendix A, Letter to Olin dated April 3, 1998). The additional seismic work was completed, but the results were deemed inconclusive by MADEP. Thus, at the request of MADEP, Olin conducted a soil-boring program in the vicinity of the intersection of Main and Eames Streets to further define the bedrock surface in the upper part of the WBV (Appendix A, Letter to Olin dated October 2, 1998). Additionally, MADEP speculated that bedrock fractures could act as a pathway for the migration of DAPL and, therefore, required Olin to complete a geophysical investigation in the WBV to determine “the degree of water-bearing bedrock fractures” (Appendix A, Letter to Olin dated October 2, 1998). The purpose of the Main Street Bedrock Saddle Investigation, reported herein, was to respond to these additional MADEP requirements.

The scope of the present study included several elements, all aimed at better understanding the conditions constraining the distribution of DAPL and its potential for future movement down into the WBV. The main elements of the Main Street Bedrock Saddle Investigations were:

- Conduct exploratory drilling to bedrock to establish the elevation, morphology, and local groundwater characteristics of the inferred Main Street Saddle;
- Obtain a continuous core through bedrock at the location of the saddle’s low point to a depth where fractures are minimal or there is no geochemical signature of DAPL for evaluation of overburden and bedrock characteristics controlling the potential for solute transport;

- Perform geophysical and hydraulic testing in the bedrock borehole at the saddle's low point and at a representative location in the WBV to identify potentially transmissive fractures through the bedrock and to quantify the hydraulic conductivity of any flow zones encountered;
- Install a multilevel piezometer (MP-4) in the bedrock borehole at the low point of the saddle with ports screened in the unconsolidated overburden and at depths corresponding to any identified transmissive bedrock fracture zones;
- Sample MP-4 and analyze for major ions, metals, and geochemical parameters.
- Calculate the flux of DAPL-related constituents across the Main Street Saddle area to determine the degree to which the saddle constrains solute transport into the WBV.

Section 2 of this report describes the field activities leading up to and culminating with the sampling of MP-4. Section 3 discusses the potential for DAPL migration and diffuse-solute transport through the Main Street Saddle region on the basis of data collected during this and previous investigations. Conclusions are presented in Section 4.

Section 2

2 FIELD PROGRAM

This section describes the fieldwork performed at the Site to identify the location, elevation, and characteristics of the bedrock saddle that was previous inferred to be present in the vicinity of Main Street and acting to restrict the migration of DAPL into the WBV. The present series of investigations was a combined effort of Geomega and LAW that included a seismic refraction survey (LAW 1999), a preliminary drilling and sampling program (Geomega 1999b), and the additional drilling and associated activities reported in this document. The most recent drilling program culminated with selecting the location for a deep bedrock core at the saddle crest, collecting the core, performing various downhole bedrock testing in the deep borehole, and ultimately constructing and sampling multilevel piezometer MP-4.

2.1 Bedrock Mapping

2.1.1 Summary of Previous Work

Seismic refraction surveying and preliminary drilling were performed along Main Street to identify the general location and elevation of the bedrock saddle. Three seismic refraction lines (Lines 1, 2, and 5) were shot near Main Street in the area of the inferred saddle (LAW 1999), and 6 borings (SB-1 through SB-6) were drilled to bedrock between August 24, 1998 and September 4, 1998 at locations selected on the basis of the seismic refraction results (Geomega 1999b). The borings confirmed the existence of the bedrock saddle. The re-interpreted bedrock surface incorporating these new data revealed that the bedrock saddle was quasi-parallel to Main Street and had a low-point elevation of approximately 40 feet above mean sea level (amsl) in the vicinity of SB-3 (Figure 2).

Groundwater samples were obtained from the preliminary borings at the top-of-bedrock and analyzed for DAPL-related parameters. Chemical data collected during the preliminary boring program supported the hypothesis that DAPL was constrained within a bedrock reservoir east of the saddle crest. Groundwater in the deeper bedrock areas east of the saddle (SB-4) was indicative of DAPL, while nearer the saddle crest (at SB-2 and SB-3) it became diluted and consistent with diffuse-zone chemistry; also, samples collected outside of the saddle-controlled reservoir area (SB-5 and SB-6) were consistent with ambient groundwater conditions (Geomega 1999b).

2.1.2 New Borings

As part of the present study, three additional borings (SB-7 through SB-9) were advanced to bedrock in the vicinity of SB-3 to more accurately delineate the lowest point of the saddle (Appendix B). The exploratory drilling was performed in two parts: initially, a perforated well point that allowed collection of groundwater samples at specific depths beneath the surface was driven through the soil to bedrock; subsequently, rotosonic (vibratory/rotary) drilling was used to enlarge the boring and collect continuous soil samples from the surface to refusal in bedrock. Field screening for groundwater specific conductance was performed on samples obtained during the initial drilling procedures at each location (Table 1) to help determine the best location for the new multilevel piezometer. On the basis of the specific conductance data and additional depth-to-bedrock information from these borings, the location of the SB-8 boring was selected for bedrock coring and the installation of multilevel piezometer MP-4 (Figure 2).

2.1.3 Saddle Configuration

Overburden materials encountered above the saddle were primarily sands and gravels to a depth of 63 feet, where a layer of clayey till containing rock fragments was encountered. At 65 feet, severely weathered bedrock was observed.

Based on the depths to bedrock in all of the Main Street borings, the available seismic data, and information from local monitoring wells, the bedrock saddle was determined to be an elongated ridge aligned approximately parallel to and just west of Main Street. The lowest point of the saddle, at the northern end of the bedrock ridge, was found to be at an elevation of approximately 32 feet amsl.

2.2 Bedrock Saddle Coring

The continuation of boring SB-8 into the bedrock was advanced with a coring rig. Continuous core was obtained, logged in the field, and stored in the core shed at the

Property. The boring log is included with the summary report of field activities (Appendix B). The initial depth of the boring was 160 feet below ground surface (bgs). However, the hydrophysical log from SB-8 indicated that a substantial flow of high conductivity groundwater was entering the boring near its base. Following consultation with C. Pyott (MADEP), the boring was extended from 160 feet to 176 feet bgs, which included an 8-foot zone of unfractured rock below the deepest fracture (encountered at 168 feet bgs).

2.2.1 Summary of Observed Conditions

Between depths of 65 to 75 feet bgs, extremely weathered bedrock was encountered. Specific fractures and foliation were unobservable in this interval due to the broken nature of the rock. At a depth of 74 feet bgs, an aluminum-chromium mineral phase was identified by scanning electron microprobe analysis (discussed in greater detail in Section 3.2.1). From 75 to 87 feet bgs, weathered gneiss was observed, with evidence of a reaction with the DAPL in shallower fractures. Below 87 feet bgs, the predominant lithology encountered was amphibolite gneiss, with minor occurrences of diabase and quartzite. The bedrock contained numerous fractures, most of which were calcite-filled. The majority of the fractures identified in the core dip at an angle greater than 45º. A description of the core is provided in Appendix B.

2.3 Downhole Testing

Downhole testing—consisting of hydraulic packer tests, Borehole Image Processing System (BIPS) logging, and hydrophysical logging—was performed in the bedrock portion of SB-8 to determine fracture density and orientation and the hydraulic conductivity of transmissive fracture zones. These tests were also performed in open sections of monitoring wells GW-62BR and GW-62BRD to establish comparative data for adjacent areas in the WBV.

2.3.1 Packer Testing

The cored interval of the SB-8 boring and the open-hole intervals in GW-62BR and GW-62BRD were packer tested using a double packer system, with a spacing of approximately 10 feet between the packers. LAW observed the packer tests, which were conducted by the drilling contractor, and analyzed the results to determine hydraulic conductivity of the bedrock at various depths (Appendix B). In summary, the estimated bedrock hydraulic conductivities at SB-8 ranged between 0.01 and 0.5 feet per day (ft/d) and averaged 0.1 ft/d, while at the location of the GW-62 bedrock wells the range was 0.007 to 0.05 ft/d with an average of 0.02 ft/d.

2.3.2 BIPS Logs

The BIPS logging tool is a digital borehole scanner that provides oriented, full-color images of the borehole wall (e.g., Figure 5). The instrument produces high-resolution images, allowing determination of fracture orientation and visual characteristics of the borehole wall. Scrolling images of the borehole walls were recorded on videotape and can also be reproduced on paper copy. Summaries of the results of BIPS logging in SB-8, GW-62BR, and GW-62BRD are included in Appendix C.

Fracture orientations derived from the BIPS data, shown as rose diagrams from the three wells (Figures 6 through 8), demonstrate that the fracture strikes are predominantly northeast with dips of 45° to 60°, which is consistent with the observations of surface bedrock fractures reported in Smith (1997). The predominant fracture orientation is shown in cross section on Figure 9, including a correction for vertical exaggeration. The orientation is such that the fractures would not be expected to connect the Main Street Saddle region with the WBV.

2.3.3 Hydrophysical Logs

In order to identify the depths of conductive fractures that potentially do or could contain DAPL, hydrophysical logs were collected in the bedrock portions of GW-62BR, GW-62BRD, and SB-8 (the location of MP-4). Initially the boreholes were prepared by simultaneously injecting deionized water at the bottoms of the borings while pumping from the tops of the water columns until the boreholes were completely replaced with deionized water (based on conductivity measurements made just below the pump intake). At that point the deionized water injection was terminated, but pumping continued.

During pumping, a downhole conductivity probe was used several times to continuously measure the conductivity of the fluid over the entire depth of the open hole. The conductivity profiles (Figures 10 through 12) showed the depths at which fractures allowed conductive water to enter the borehole, thereby identifying those fractures capable of transmitting measurable quantities of groundwater.

At early times, fractures providing water to the boring are identified as spikes in the curves. Over time, higher conductivity formation water continues to flow into the boring and upwards under the influence of pumping. As a result, the curves flatten with time above the higher transmissivity zones. By analyzing the change in conductance over time, the hydraulic conductivity and transmissivity can be calculated (Appendix D).

Table 2 lists results of the transmissivity calculations based on the hydrophysical logging. Nine flow intervals were identified in the bedrock portion of SB-8, with calculated transmissivities ranging from 2.86 ft^2/d to 8.81 ft^2/d in specific flow intervals. Seven flow intervals were observed in GW-62BR, with calculated transmissivities ranging from 1.26×10^{-2} ft^2/d to 4.36×10^{-1} ft^2/d. Inflow into the boring was primarily from fractures in a rubbleized (weathered) zone beneath the bottom of the casing in the open hole. Nine flow zones were observed in GW-62BRD, with calculated transmissivities ranging from 9.96×10^{-2} ft^2/d to 9.01×10^{-1} ft^2/d.

2.4 MP-4 Construction

Multilevel piezometer MP-4 was constructed in boring SB-8 after reaming the boring to increase the diameter to 5 inches. The piezometer was built from 2-inch diameter PVC casing with fourteen 6-inch stainless steel sampling ports. Bentonite, sand, and sample port intervals of MP-4 are illustrated on the well diagram included with the boring record for SB-8 (Appendix B). The depths of the sampling ports were selected on the basis of results of the hydrophysical and BIPS logging, and visual inspection of the core. Teflon tubing was attached to the ports for sampling access and each port on the tubing bundle was clearly labeled to facilitate future sampling efforts. The total volume and disposition of water derived during field screening, rock coring, packer testing, and development of the well is described in Appendix B.

2.5 MP-4 Development and Sampling

Development and sampling of MP-4 occurred between June 27 and June 29, 2000. The ports were developed individually by pumping until the water was free of visual suspended sediment and field parameters (pH, Eh, SC, temperature, and dissolved oxygen), measured in a flow-through cell, stabilized (Table 3). After stabilization, additional field parameters (Fe, Fe^{+2}, sulfate, and sulfide) were measured with a HACH kit. Ports #4, #6, and #7 did not produce sufficient water for sampling. However, groundwater samples were successfully collected from the remaining ports and were submitted under appropriate handling and chain-of-custody protocol for laboratory analysis. The samples were analyzed for a variety of organic, inorganic, and geochemical parameters. The chain-of-custody forms and analytical results of the MP-4 initial sampling event are provided in Appendix E.

2.5.1 Summary of Analytical Results

Table 4 summarizes the MP-4 analytical results for the four major DAPL constituents—ammonia, sulfate, sodium, and chloride—as well as for Cr(III), Cr(VI), and specific gravity. The results indicate that groundwater to a depth of <60 feet bgs contains relatively low concentrations of inorganic parameters in comparison with the deeper groundwater. The concentrations increase sharply across a “transition” zone at the top of the saddle (MP-4 Ports #10 and 9; 60 and 64 feet bgs, respectively) and remain relatively high in the weathered bedrock and upper part (~35 feet) of the underlying bedrock (Figure 13). Combined concentrations of the four major DAPL constituents in the shallow groundwater (<60 feet bgs) above the saddle are one to two orders of magnitude lower than the concentrations in the transition zone or at deeper depths within the bedrock. Concentrations of DAPL-indicator parameters generally decrease below a depth of approximately 110 feet bgs.

3 EVALUATION OF POTENTIAL FOR DAPL MIGRATION

Three types of data resulting from the Main Street Boring Investigation have a direct bearing on the question of whether or not the DAPL has the potential for future migration into the WBV. These data include:

- the calculated mass flux of DAPL-related solutes through the saddle area based on observed transmissivities in the SB-8 boring and the sampling results from MP-4,
- observations of fracture-filling and pore-clogging precipitates resulting from geochemical reactions of DAPL solutes, and
- determination of the elevation of the Main Street Saddle and its relationship to previously measured top-of-DAPL elevations throughout the area of current DAPL distribution.

This section discusses the implications each of these components has on potential DAPL migration and diffuse-solute transport through the Main Street Saddle region. Collectively, the data generated by this and prior investigations form a basis for explaining the current distribution of DAPL and assessing its potential for future westward migration within the MMBA.

3.1 DAPL-Related Mass Flux Through Saddle Area

Calculated bedrock-fracture transmissivities based on the SB-8 boring data and prior determinations of the hydraulic conductivity of overburden deposits were combined with water-quality sampling data from MP-4 to estimate the mass flux of DAPL-related constituents through bedrock fractures within the Main Street Saddle and through unconsolidated materials above the saddle. Sections 3.1.1 and 3.1.2 describe the methods that were used to calculate mass fluxes through the overburden deposits and bedrock, respectively. Section 3.1.3 discusses results of the mass flux calculations.

3.1.1 Unconsolidated Overburden

The hydraulic conductivity of unconsolidated overburden deposits overlying the Main Street Saddle has not been directly measured. However, horizontal hydraulic conductivities (K_h) measured elsewhere in the MMBA are typically between 20 and 250 ft/d (Geomega 2001). A value of K_h=100 ft/d was assumed to apply for bulk overburden deposits in the vicinity of Main Street.

The formation of DAPL-related precipitates (discussed below in Section 3.2) has the potential for occluding aquifer porosity, which would reduce the effective hydraulic conductivity of affected aquifer materials. Presumably, the affected region is immediately adjacent to the DAPL and coincides with the "transition" zone at the top of the saddle, as described above in Section 2.5.1. Additionally, the SB-8 boring log (Appendix B) indicates that the transition zone occurs in an area identified as till, which generally has a lower hydraulic conductivity than the other types of overburden deposits that occur in MMBA. For either or possibly both of these reasons, the transition zone hydraulic conductivity is expected to be lower than that of the overlying unconsolidated materials.

Because the hydraulic conductivity of the transition-zone material has not been directly measured, calculations of DAPL-related mass flux were made for two cases: one in which the hydraulic conductivity was conservatively assumed to be similar to bulk overburden deposits elsewhere in MMBA (K_h=100 ft/d), and another in which the hydraulic conductivity was assumed to be reduced by two orders of magnitude (K_h=1 ft/d), relative to the conservative value. The lower value of hydraulic conductivity used in the calculations is consistent with the value assigned to till units in the Olin Site numerical groundwater flow model (Geomega 2001).

As mentioned above in Section 2.5.1, concentrations of DAPL-related constituents in shallow groundwater above the saddle are roughly two orders of magnitude lower than the concentrations in the transition zone or at deeper depths within the bedrock (Figure 13). Thus, for the purpose of calculating DAPL-related mass flux, the shallow groundwater zone was assumed to contribute a negligible amount to the chemical mass flux through the Main Street Saddle area.

3.1.2 Bedrock Fractures

The transmissivities of individual fractures observed in the SB-8 boring were calculated from the hydrophysical logging data. Details of the calculations are presented in Appendix D. In summary, the rate of change of fluid conductivity as the deionized water is replaced with formation water was used to calculate the rate of groundwater flow into the borehole. In turn, the rate of flow into the borehole through specific fracture zones was combined with the chemical concentrations measured at corresponding intervals in MP-4 to calculate the solute mass flux through the bedrock fractures.

3.1.3 Composite Profile

Figure 14 shows the transmissivity profile calculated for the Main Street Saddle area on the basis of the aforementioned estimate of overburden hydraulic conductivity and fracture transmissivities measured in the SB-8 boring. The substantial decrease in transmissivity below the overburden/bedrock interface indicates that there is little, if any, potential for significant groundwater flow through bedrock.

Table 5 shows the calculations of solute fluxes in the unconsolidated deposits (transition zone) just above the saddle, within the weathered bedrock at the saddle crest (Flow Intervals #1 and 2), and within the fractured bedrock (Flow Intervals #3 through 9). Results of the calculations, in terms of annual solute fluxes, are displayed graphically on Figure 15.

It is apparent from the results shown on Figure 15 that the transition zone at the overburden/top-of-bedrock interface is the most significant region of solute mass flux. However, even with a very conservative (high) assumption for the transmissivity value of the transition zone material (400 ft^2/d, corresponding to K_h=100 ft/d), annual mass flux as a proportion of the remaining DAPL mass behind the Main Street Saddle is calculated to be less than 1.0% per year. In this case, it would take approximately 100 years for the remaining DAPL to migrate through the Main Street Saddle area. Under a more realistic assumption for the transmissivity value of the transition zone material (4 ft^2/d, corresponding to K_h=1 ft/d), annual mass flux as a proportion of the remaining DAPL mass behind the Main Street saddle is calculated to be 0.3% per year. In this case, it would take more than 300 years for the remaining DAPL to migrate through the Main Street Saddle area. Thus, on the basis of mass flux calculations, the Main Street Saddle appears to be functioning as an effective barrier to downgradient DAPL migration.

3.2 DAPL Reactions

Previous investigations delineating the spatial distribution of inorganic parameters and assessing the mobility of DAPL constituents (primarily chromium) suggested that precipitation reactions could affect the fate and transport of inorganics in the aquifer (CRA 1993; Smith 1997). Subsequently, precipitate phases have been identified both in bedrock and in the DAPL-bearing and adjacent parts of the overburden aquifer. The qualitative effects that such precipitates have on DAPL-related solute transport are considered in this section.

3.2.1 Precipitates and Fracture Filling

The precipitation of solid phases plays an important role in the overall fate and transport of DAPL constituents. The effects of precipitate formation include:

- occlusion of primary aquifer porosity and filling bedrock fractures,
- reduction of diffusive flux of DAPL constituents into overlying groundwater,
- reduction of the dissolved mass of DAPL constituents in the aquifer, and
- neutralization of DAPL acidity.

The DAPL-related precipitate phase observed in the aquifer is an aluminum-chromium (Al-Cr) sulfate mineral, which has a composition of $CrAl_2SO_4(OH)_7$. The occurrence of this mineral phase was first observed by Geomega in aquifer overburden material obtained from a boring (CPT-2) located near multilevel piezometer MP-2, and was identified by scanning electron microprobe analysis (Figure 16).

Calculations of DAPL and diffuse groundwater chemistry using the geochemical code “React” (Bethke 1999) show that waters within and immediately surrounding the DAPL are at saturation with the Al-Cr sulfate mineral, indicating suitable conditions for precipitation. Also, Eh-pH measurements confirm that Olin Site groundwater is within the stability field of the Al-Cr sulfate mineral (Figure 17). Under these conditions, precipitation of the Al-Cr sulfate mineral is hypothesized to be a result of the interaction of DAPL with aquifer materials and groundwater, which involves dissolution of silicate minerals and neutralization of a portion of the DAPL acidity. The reaction is not surprising considering the unique geochemistry of the DAPL relative to natural systems. In particular, the DAPL has low pH, high acidity, high metals content, and is mildly reducing. With this unusual composition, the DAPL is highly reactive with many different geologic materials and other waters.

In addition to being present in overburden material at the CPT-2 boring, the Al-Cr sulfate mineral was also identified by Geomega in weathered bedrock at the DAPL/diffuse-zone interface in the SB-8 boring (Figure 18). At this interface, the Al-Cr sulfate mineral precipitation occurs due to increasing pH and acid consumption resulting from the combination of alkalinity from surrounding groundwater reacting with DAPL constituents diffusing into this water. The Al-Cr sulfate mineral precipitation also occurs within fractures of the deeper bedrock, where acidic DAPL is neutralized by existing calcite in the bedrock material. The results of the reaction occurring in bedrock are apparent in the SB-8 core (Figure 19) and also can be seen in the in-situ view provided by the BIPS log (Figure 20).

In summary, it is Geomega’s opinion that, as the DAPL historically migrated into the WBV and came to rest in bedrock depressions, the total mass of acidity and metals content of the DAPL dramatically decreased due to reactions with surrounding groundwater and aquifer materials. These processes are probably still continuing to some extent as ambient groundwater flows over the surface of the remnant DAPL and provides alkalinity to neutralize and precipitate DAPL constituents in the aquifer. The reactions cause the Al-Cr sulfate mineral to be precipitated, thereby occluding primary aquifer porosity and filling bedrock fractures. In turn, the occlusion of aquifer porosity and fracture filling caused by mineral precipitation would be expected to reduce the effective hydraulic conductivity of both overburden and fractured bedrock in contact with the

DAPL, and thereby limit the diffusive flux of constituents from the DAPL into overlying groundwater.

3.3 Top of DAPL Elevations

The top-of-DAPL elevations provide a key piece of information in the evaluation of potential DAPL migration into the WBV. The extent of DAPL and the elevations of the top of the DAPL have been determined from a variety of data, including terrain conductivity mapping, downhole inductance logging, specific conductivity profiling, and water quality sampling of monitoring wells and multilevel piezometers. The methods used to collect and analyze these data and results of the analyses are reported in several Phase II documents (Geomega 1998, 1999a, 2000a, 2000b; Smith 1997).

A map of the measured top-of-DAPL elevations reveals two surfaces, an upper DAPL pool at ~60 feet amsl extending from beneath the Property to Jewel Drive and a lower DAPL pool at ~40 feet amsl extending west from Jewel Drive to just west of Main Street (Figure 21). Within each pool, the top-of-DAPL surface has a fairly uniform elevation. Importantly, these elevations do not appear to have changed appreciably since 1992 when the first inductance logging was performed (Geomega 2000a).

It is significant that the top-of-DAPL elevation of the lower pool is observed to be very close to the elevation of the Main Street Saddle (within the measurement uncertainties). Because disposal of liquid wastes to unlined pits and ponds on the Property ceased in 1971, there have been no additions to the DAPL since that time. Thus, the bedrock depression east of the Main Street Saddle has apparently remained filled with DAPL for the last 30 years. The fact that the top-of-DAPL elevation of the lower pool is still at approximately the overflow elevation of the saddle crest even after 30 years indicates that there has been no substantial loss of DAPL via migration through bedrock fractures; otherwise, the top-of-DAPL elevation would now be lower than the saddle crest.

A gap exists in the bedrock control data between GW-43D and GW-45D (Figure 21), spanning the elevation change in the top-of-DAPL surface. However, based on what is known about the top-of-DAPL elevation of the lower pool and the elevation of the Main

Street Saddle, an intermediate bedrock saddle is inferred to exist in the area between GW-43D and GW-45D (Figure 22). To constrain the DAPL remnant in the upper pool, the intermediate bedrock saddle is expected to have a crest elevation of approximately 60 feet amsl.

Section 4

4 CONCLUSIONS

The existence of the Main Street Bedrock Saddle was confirmed and the saddle’s morphology and elevation were determined as a result of the investigations described in this report. The saddle consists of a subsurface ridge of bedrock that protrudes into the unconsolidated overburden aquifer and acts as a dam, preventing downgradient flow of DAPL along the top-of-bedrock surface into other parts of the MMBA. Downhole testing in SB-8, at the low point of the saddle crest, and in open bedrock wells in the WBV provided data for assessing the effectiveness of the bedrock dam in constraining DAPL migration. Results of the investigations have demonstrated the following:

- Bedrock of the Main Street Saddle contains numerous fractures, most of which are calcite filled. In situ testing showed that groundwater flow does occur in a few fracture zones within bedrock, however those fracture zones have a relatively low overall effective transmissivity. Additionally, the predominant fracture orientation in the Main Street Saddle is such that most of the bedrock fractures would not be expected to intersect the WBV, even if they were continuous throughout the intervening distance. Thus, the bedrock fracture data indicate that there is little, if any, potential for migration of DAPL through bedrock.

- Water-quality data from MP-4 and ancillary data from other investigations support the finding that Main Street Saddle appears to be functioning as an effective barrier to downgradient DAPL migration. Figure 23 shows measured specific conductance values and ammonia concentrations in a cross section from the DAPL area through the location of MP-4 and into the WBV. These data reveal that intermediate locations between MP-4 and GW-83D in the WBV have much lower values of DAPL-indicator parameters than either the Main Street Saddle or WBV areas, demonstrating that the DAPL-related solutes observed in the MP-4 fractures are not being transported through bedrock to the WBV. Instead, historical overtopping of the Main Street Saddle is thought to have resulted in DAPL flow down the bedrock channel between GW-58D and GW-62 toward the

WBV and produced the remnant pools of concentrated liquids that remain trapped in bedrock surface depressions in the WBV.

- DAPL-related mass flux calculations based on measured concentrations in a vertical profile through the Main Street Saddle also support the finding that there is little, if any, potential for migration of DAPL through bedrock. Estimates of the mass fluxes across the saddle region, including unconsolidated deposits in the transition zone at the DAPL/diffuse interface and the severely weathered upper part of the bedrock, indicate that it would take roughly 100 to 300 years for the remaining DAPL to migrate past the saddle. The low mass flux rates are consistent with the observation that, even after 30 years, the top-of-DAPL elevations remain at the overflow elevation of the saddle crest, indicating that there has been no substantial loss of DAPL pooled east of the bedrock saddle.
- The formation of DAPL-related precipitates likely contributes to the general stasis of the DAPL by virtue of occluding primary aquifer porosity and filling bedrock fractures, and thus reducing the diffusive flux of DAPL constituents into overlying groundwater.

Section 5

5 REFERENCES

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Tables

Table 1. Specific Conductance of Groundwater in Main Street Saddle Borings

SB-7		SB-8		SB-9	
Boring Depth (ft bgs)	Specific Conductance (umhos/cm)	Boring Depth (ft bgs)	Specific Conductance (umhos/cm)	Boring Depth (ft bgs)	Specific Conductance (umhos/cm)
25	333	26	477	30	464
30	313	31	138	35	319
35	285	36	182	40	330
40	262	41	217	45	341
45	296	46	290	50	537
50	372	51	348	55	4380
55	618	56	452	60	14,560
60	2944	60	4510		
65	3715	65	17,870		

Notes:
Field screening data obtained during initial drilling, as explained in Section 2.1.2.
bgs = below ground surface.

Table 2. Calculated Transmissivities of Bedrock Borings

SB-8/MP-4				GW-62BR			GW-62BRD		
Flow Interval	Corresponding MP-4 Port	Port Depth (ft bgs)	Transmissivity (ft^2/d)	Flow Interval	Depth (ft bgs)	Transmissivity (ft^2/d)	Flow Interval	Depth (ft bgs)	Transmissivity (ft^2/d)
1	8	74	6.81	1	79	0.2910	1	105	0.2460
2	8	74	8.81	2	81	0.0821	2	118	0.2130
3	5	110	4.7	3	84	0.0569	3	122	0.1380
4	5	110	4.59	4	85	0.0505	4	126	0.1800
5	3	143	2.89	5	93	0.4360	5	129	0.4240
6	3	143	2.89	6	94	0.0126	6	131	0.0996
7	3	143	2.86	7	99	0.1420	7	135	0.7100
8	3	143	2.88				8	141	0.4000
9	2	155	5.45				9	142	0.8780

Notes:

Methodology and calculation details are explained in Section 2.3.3 and Appendix D.

Table 3. Field Measurements from MP-4

Sample Port No.	Depth (ft bgs)	Elevation (ft amsl)	DO (mg/l)	pH	Temp (C)	SC (umhos/cm)	Eh (mV)	Fe (mg/l)	Fe^{+2} (mg/l)	Sulfate (mg/l)	Sulfide (mg/l)
14	24	72.47	0.2	5.93	14.8	117.4	177	0.68	0.56	20	0
13	39	57.47	0.4	6.19	15	378	129	13	10	27	0
12	50	46.47	0.2	6.16	15	859	56	17	15	60	0
11	55	41.47	0.1	6.41	14.9	2310	-55	22	19	13	0.36
10	60	36.47	0.5	4.8	16	17,570	416	1000	1100	10,000	0.9
9	64	32.47	1.1	4.5	15.7	22,500	391	1700	1000	0	0
8	74	22.47	0.7	5.5	18.4	16,700	323	1000	800	0	1.3
7	85	11.47	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	99	-2.53	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	110	-13.53	0.8	6	17.1	26,900	252	10,200	9700	520	0
4	127	-30.53	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	143	-46.53	2.3	5.5	17.2	15,000	321	310	251	5700	0.05
2	155	-58.53	1.9	5.9	18.1	14,700	216	158	152	7000	0.04
1	166	-69.53	2.2	6	21.2	19,500	236	27	19	260	0.03

Notes:

Data collected 6/28/00 and 6/29/00 by Geomega personnel, as described in Section 2.5.

NA = not available.

bgs = below ground surface.

amsl = above mean sea level.

Table 4. Analytical Results for MP-4 (June 2000 Data Set)

MP-4 Port Number	Depth (ft bgs)	Ammonia (mg/l)	Sulfate (mg/l)	Sodium (mg/l)	Chloride (mg/l)	Chromium III (ug/l)	Chromium VI (ug/l)	Specific Gravity
14	24	2.5	12	180	32	10 U	0.005 U	0.97
13	39	9.2	15	51	62	10 U	0.005 U	0.98
12	50	30	43	-	150	-	0.005 U	0.98
11	55	120	760	330	490	10 U	0.005 U	0.99
10	60	1900	7200	1800	4100	11000	0.005 U	1.02
9	64	2100	9200	2600	4500	40000	0.014	1.02
8	74	2100	9500	3300	6700	5500	0.005 U	1.02
5	110	1100	11000	5100	7300	320	0.058	1.03
3	143	650	5200	1500	4100	140	0.005 U	1.01
2	155	2100	6400	2400	4000	380	0.010	1.02
1	166	490	9100	4400	4900	58	0.008	1.02

Notes:
U = analyzed for, but not detected above indicated sample quantitation limit.
bgs = below ground surface.

Table 5. Comparison of DAPL Mass Fluxes Through Bedrock and Unconsolidated Deposits Based on MP-4 Data

SB-8 / MP-4 Flow Interval	Top of Interval (ft)	Bottom of Interval (ft)	Length of Interval (ft)	Transmissivity, T (ft^2/d)	Corresponding MP-4 Port	MP-4 Port Depth (ft)	Ammonia (mg/l)	Sulfate (mg/l)	Chloride (mg/l)	Chromium (mg/l)	Sum of Constituents (mg/l)	Mass Flux (kg/ft/d)
Bedrock Data												
1	75.0	79.1	4.1	6.81	8	74	2100	9500	6700	5.5	18305.5	3.53
2	84.2	86.0	1.8	8.81	8	74	2100	9500	6700	5.5	18305.5	4.57
3	99.4	99.7	0.3	4.7	5	110	1100	11000	7300	0.32	19400.32	2.58
4	110.3	111.3	1.0	4.59	5	110	1100	11000	7300	0.32	19400.32	2.52
5	128.7	130.7	2.0	2.89	3	143	650	5200	4100	0.14	9950.14	0.81
6	138.2	138.4	0.2	2.89	3	143	650	5200	4100	0.14	9950.14	0.81
7	140.0	142.1	2.1	2.86	3	143	650	5200	4100	0.14	9950.14	0.81
8	143.7	146.4	2.7	2.88	3	143	650	5200	4100	0.14	9950.14	0.81
9	153.1	157.2	4.1	5.45	2	155	2100	6400	4000	0.38	12500.38	1.93
		Total Length:	18.3								Total Mass Flux:	18.38
Unconsolidated Deposits												
--	--	--	4	--	10	60	1900	7200	4100	11	13211	
--	--	--	4	--	9	64	2100	9200	4500	40	15840	
						Averages:	2000	8200	4300	25.5	14525.5	
										Mass Flux @ T = 4 ft^2/d:	14525.5	1.65
										Mass Flux @ T = 400 ft^2/d:	14525.5	164.55

Mass Flux Calculations:

1. Bedrock

Total Length of Bedrock Borehole = 82.2 ft

Mass Flux per Unit Cross-Sectional Area = (18.38 kg/ft/d) / (82.2 ft)

= 0.22 $kg/ft^2/d$

2. Unconsolidated Deposits

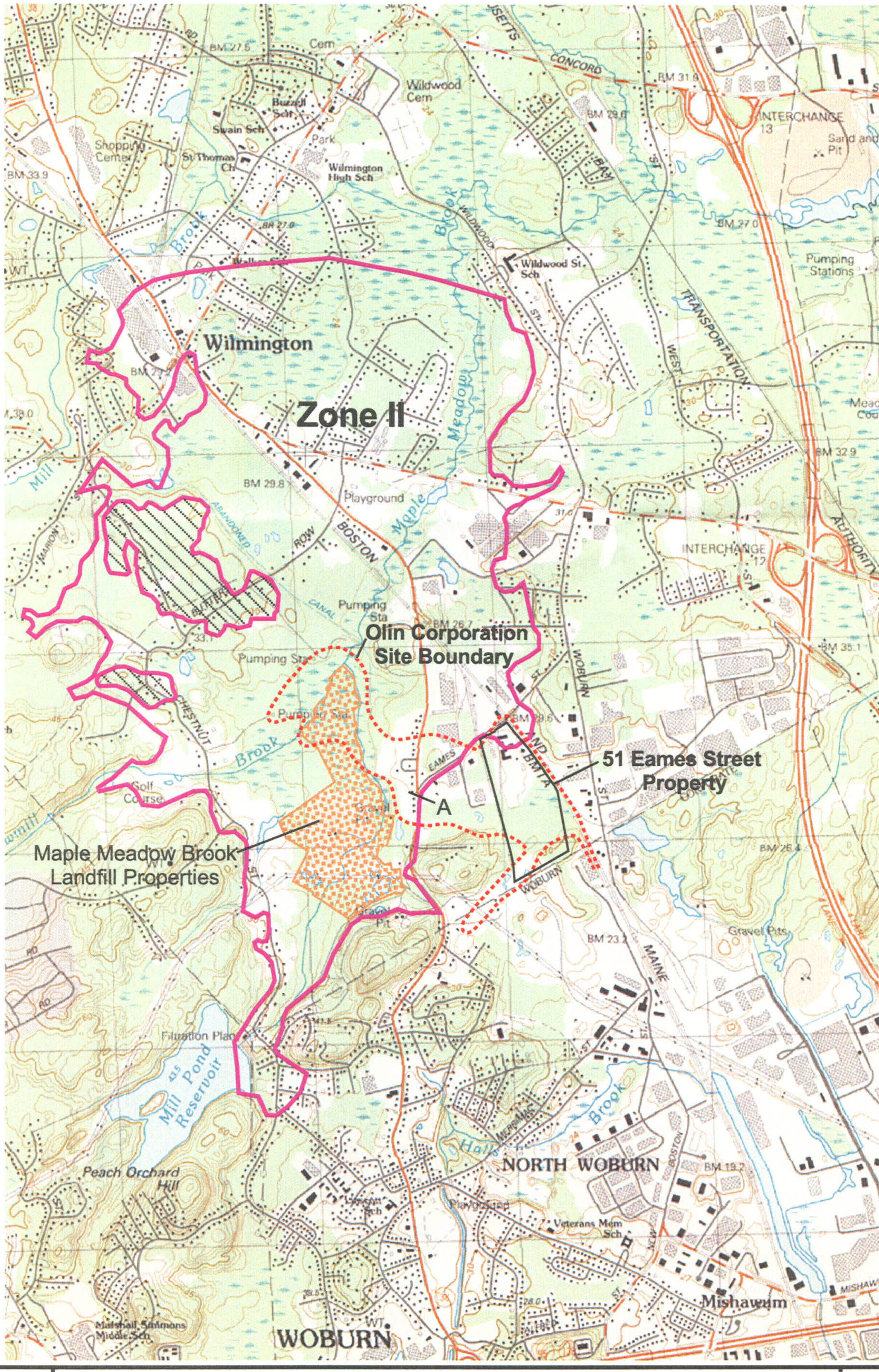
Mass Flux per Unit Cross-Sectional Area with Transmissivity @ 400 ft^2/d = (164.55 kg/ft/d) / (4 ft)

= 41.12 $kg/ft^2/d$

Mass Flux per Unit Cross-Sectional Area with Transmissivity @ 4 ft^2/d = (1.65 kg/ft/d) / (4 ft)

= 0.41 $kg/ft^2/d$

Figures



Generation Date: 12/19/01	Figure 1. Location map.	Geomega

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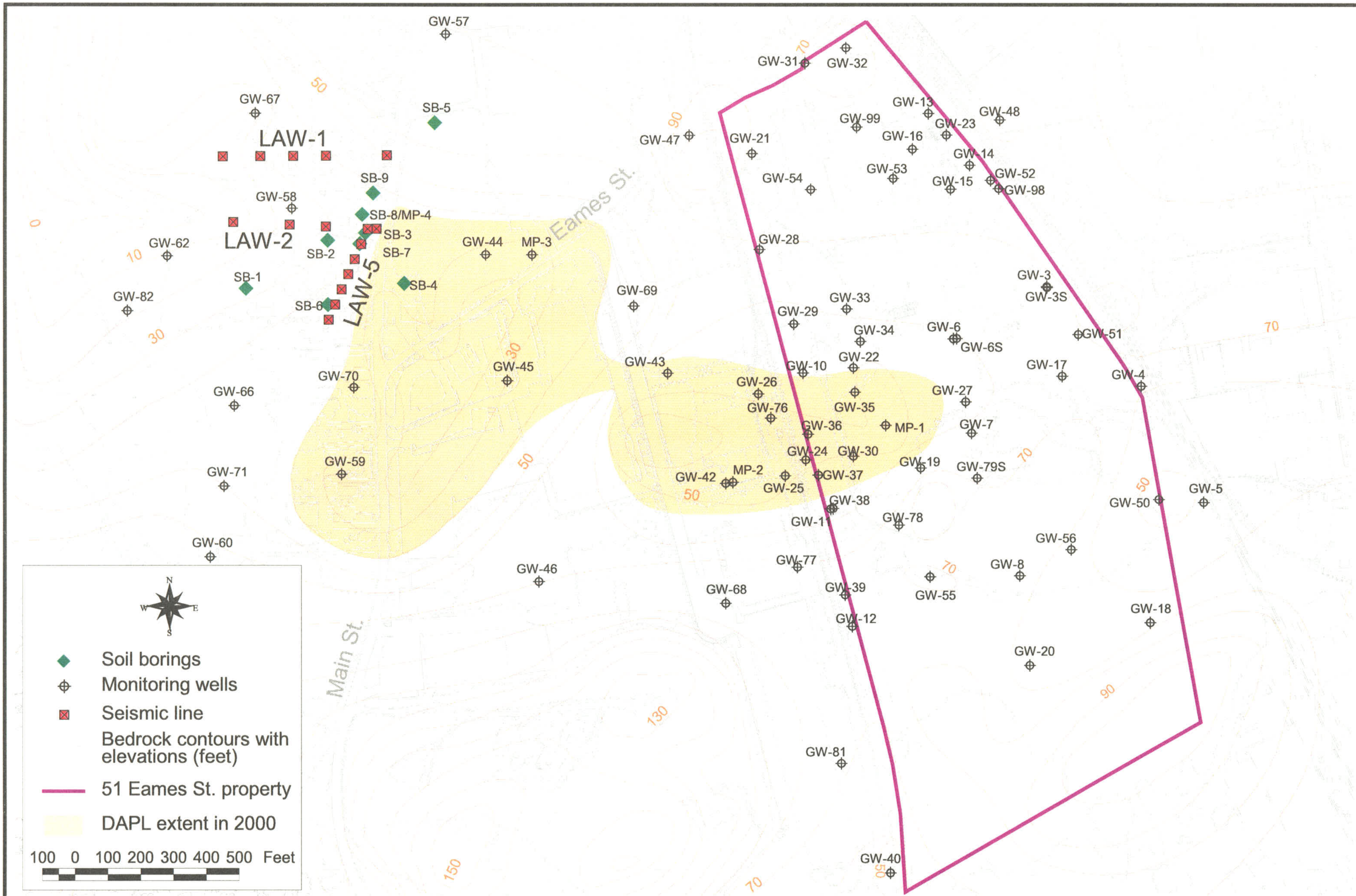

Generation Date: 12/19/01	Figure 2. Locations of recent seismic lines and borings used to delineate Main Street bedrock saddle and extent of DAPL in 2000.	Geomega

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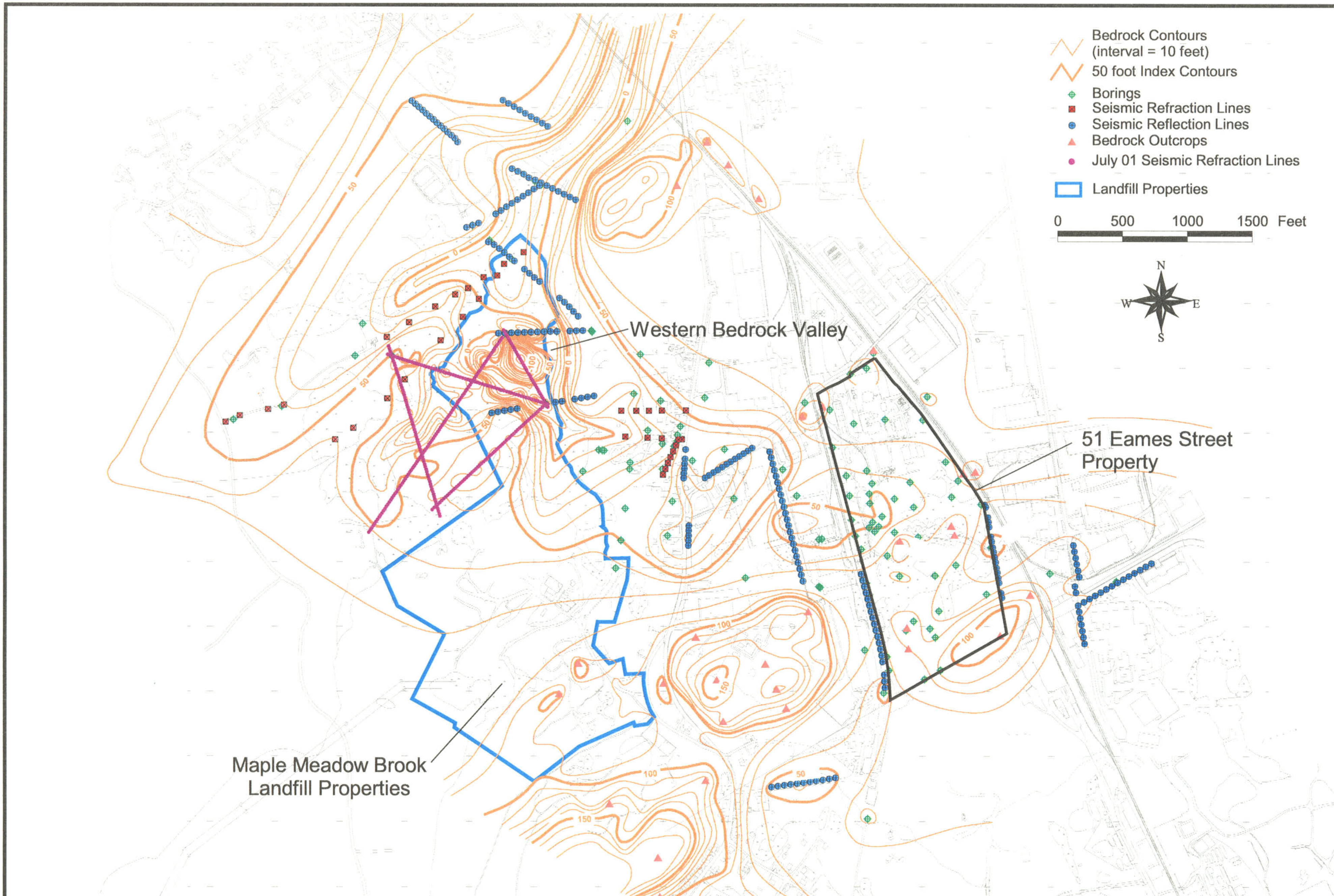

Generation Date: 12/19/01	Figure 3. Bedrock elevation contour map and locations of available control data.	Geomega

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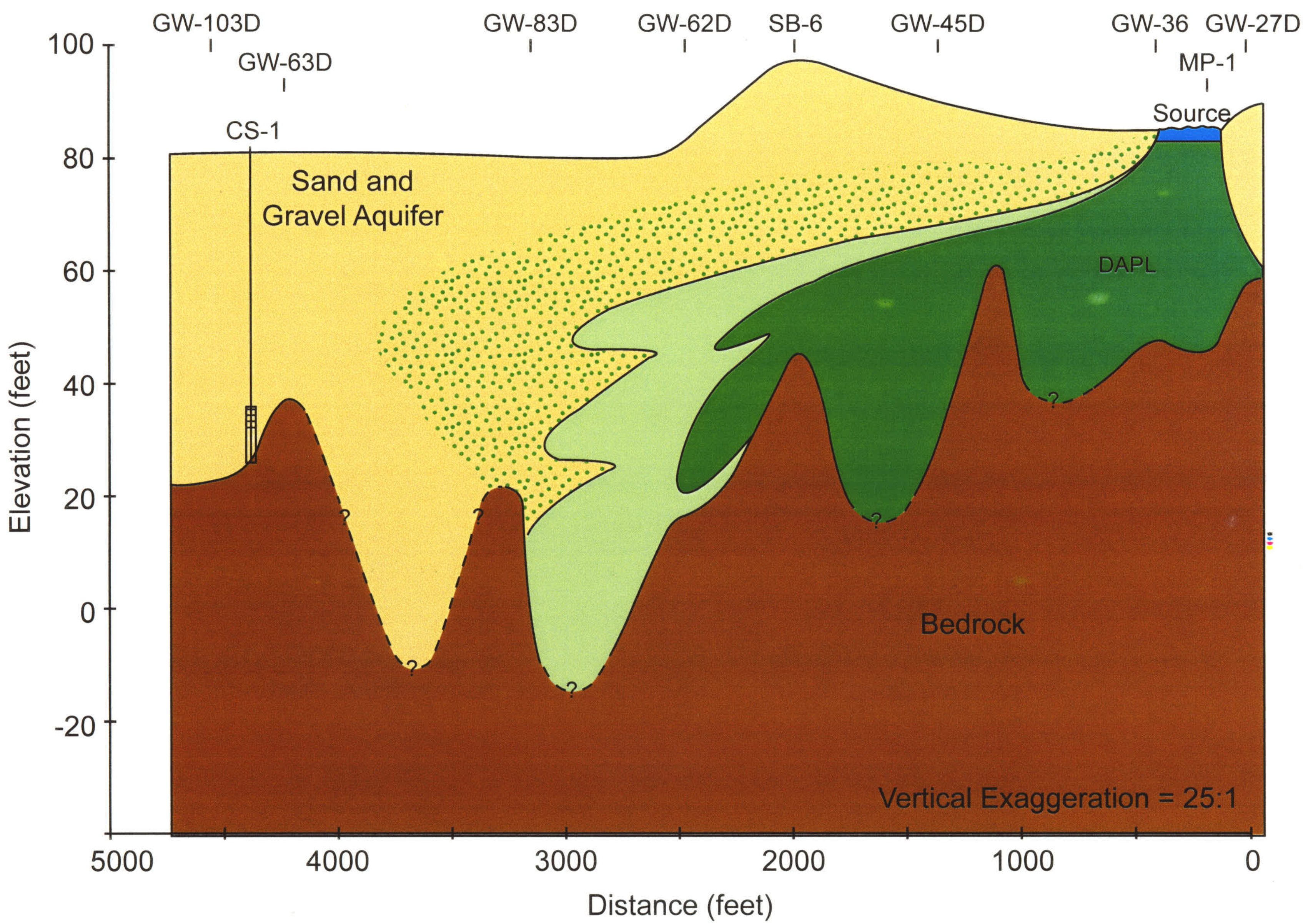

Generation Date: 12/18/01	Figure 4. Historical flooding of liquid waste.	Geomega

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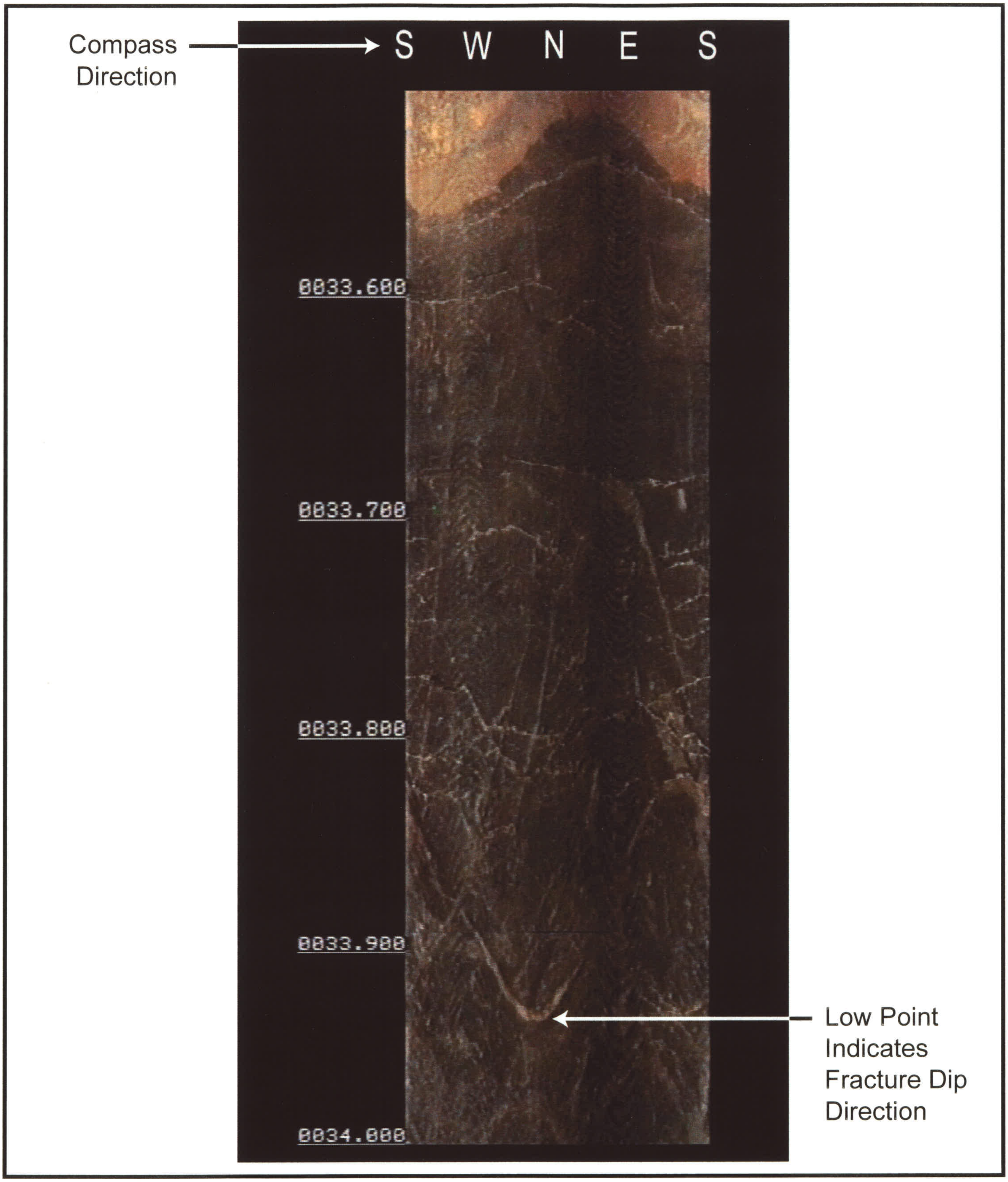

Generation Date: 12/18/01	Figure 5. Example BIPS log from the bedrock in the Main Street Saddle.	Geomega

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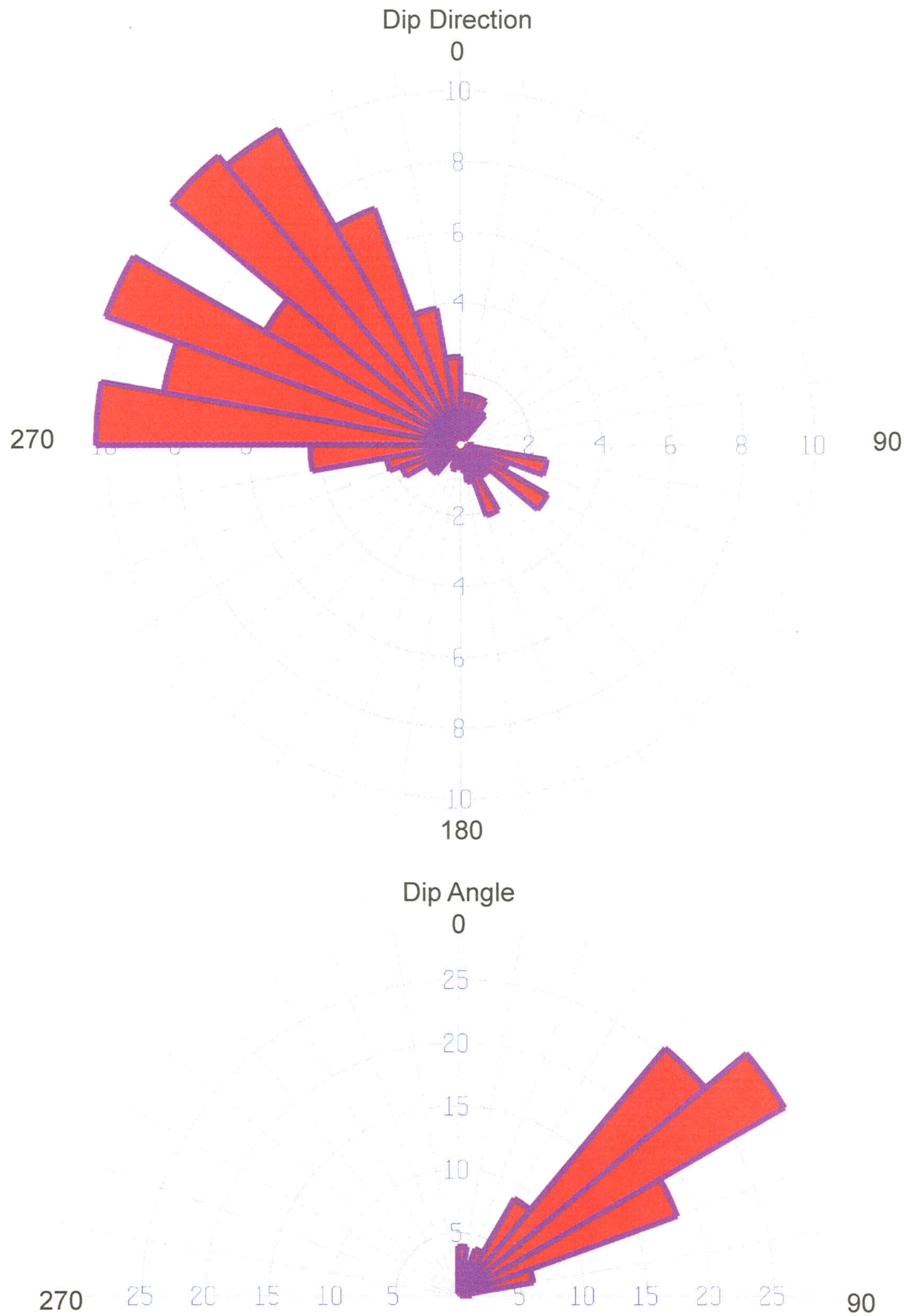

Generation Date: 12/18/01	Figure 6. MP-4 bedrock fracture orientation.	Geomega

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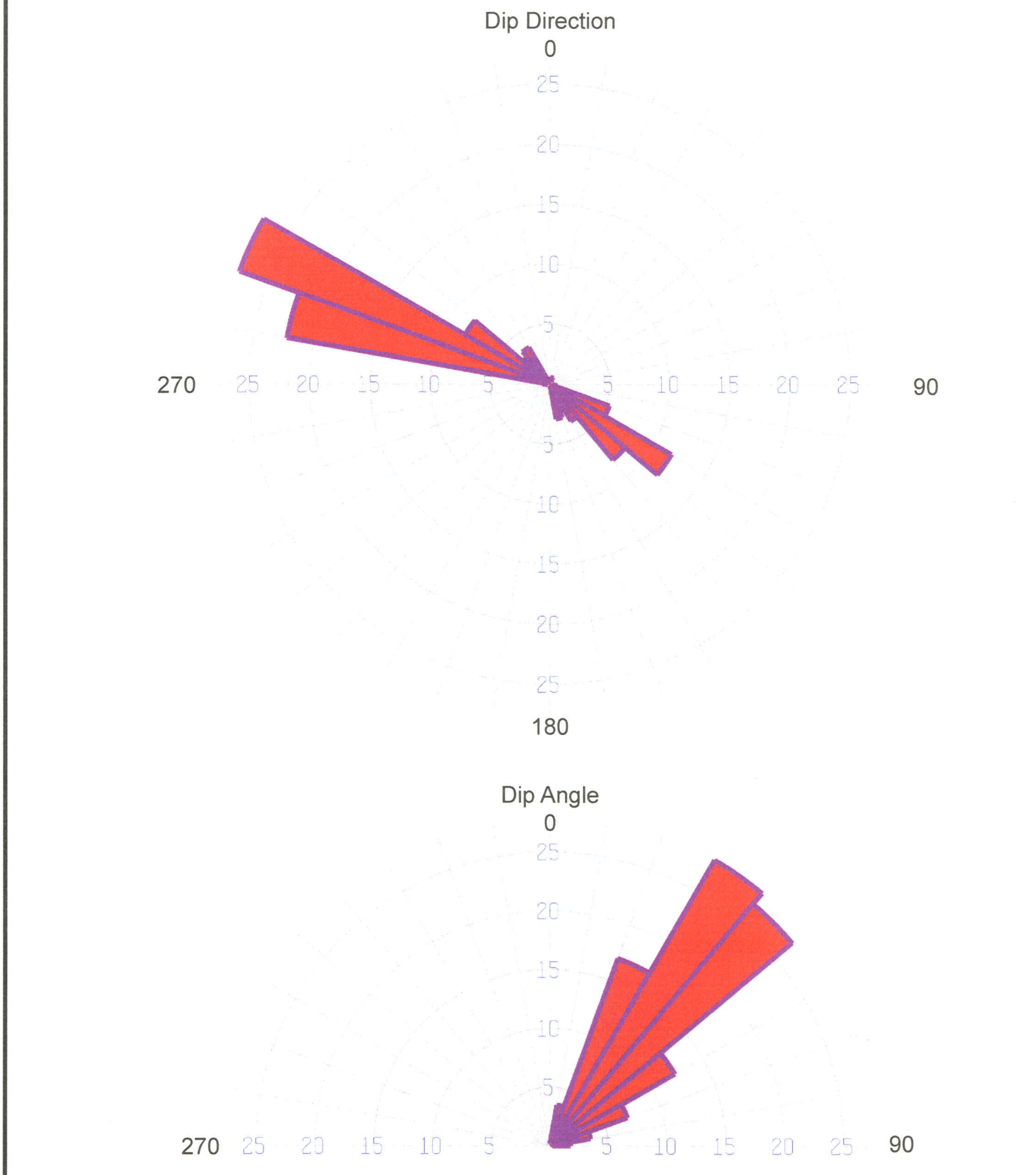

Generation Date: 12/08/01	Figure 7. GW-62BR bedrock fracture orientation.	Geomega

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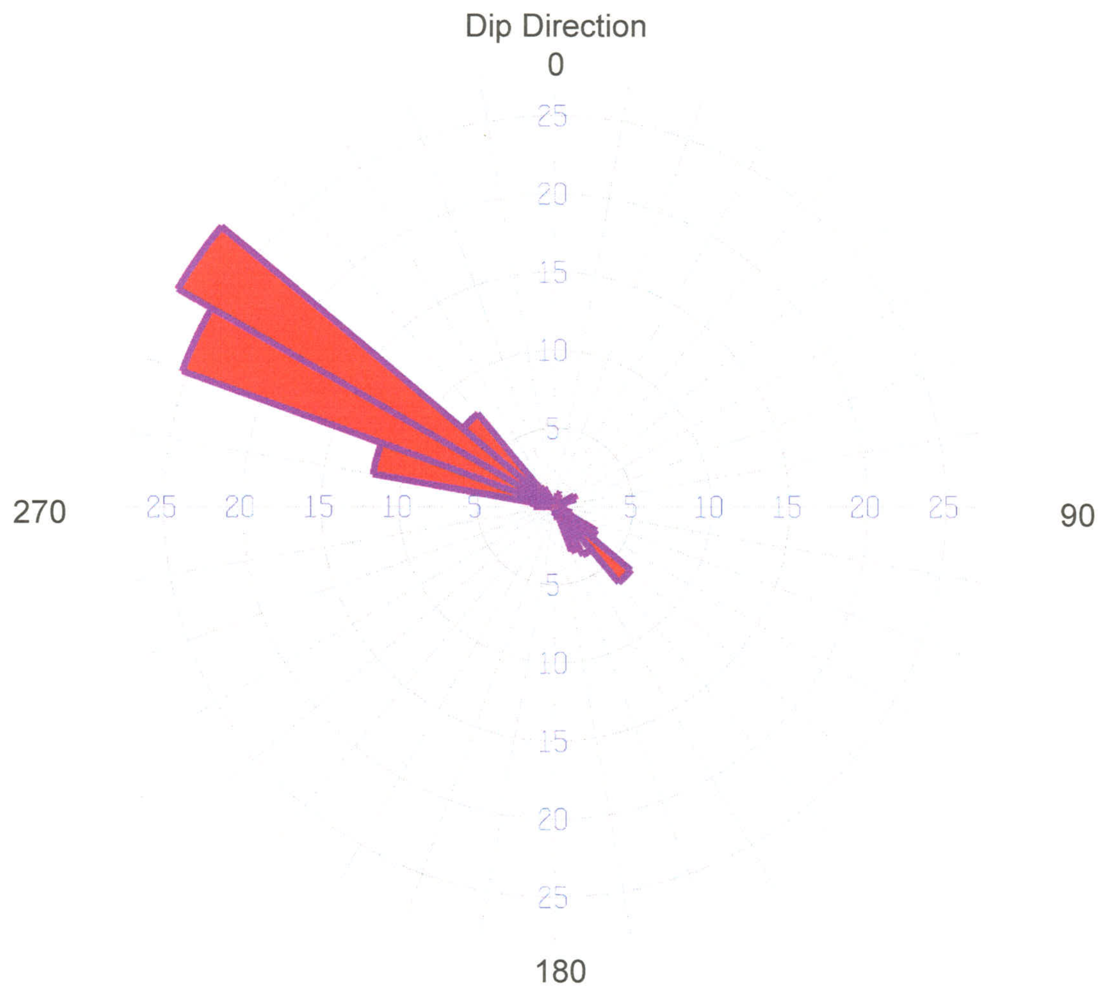

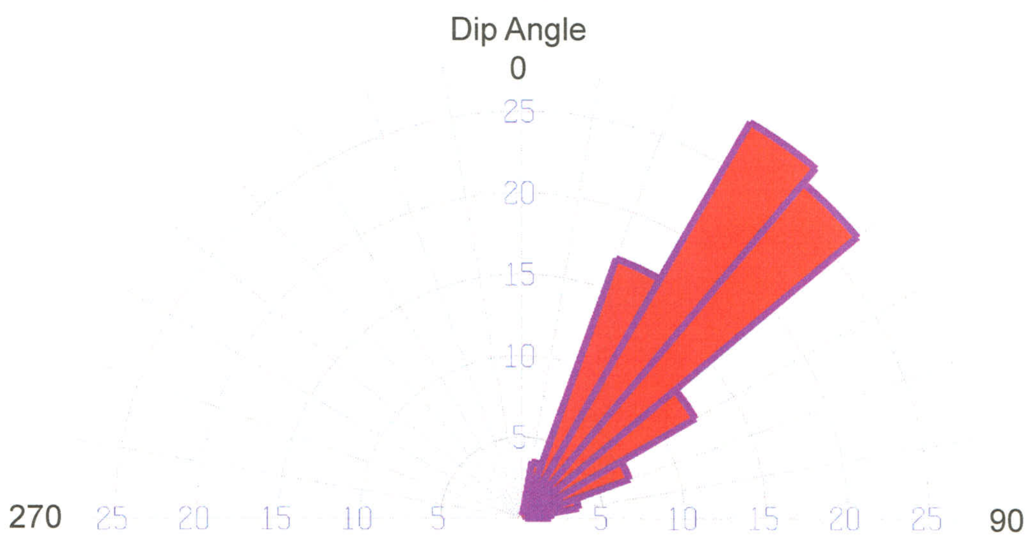

Generation Date: 12/18/01	Figure 8. GW-62BRD bedrock fracture orientation.	Geomega

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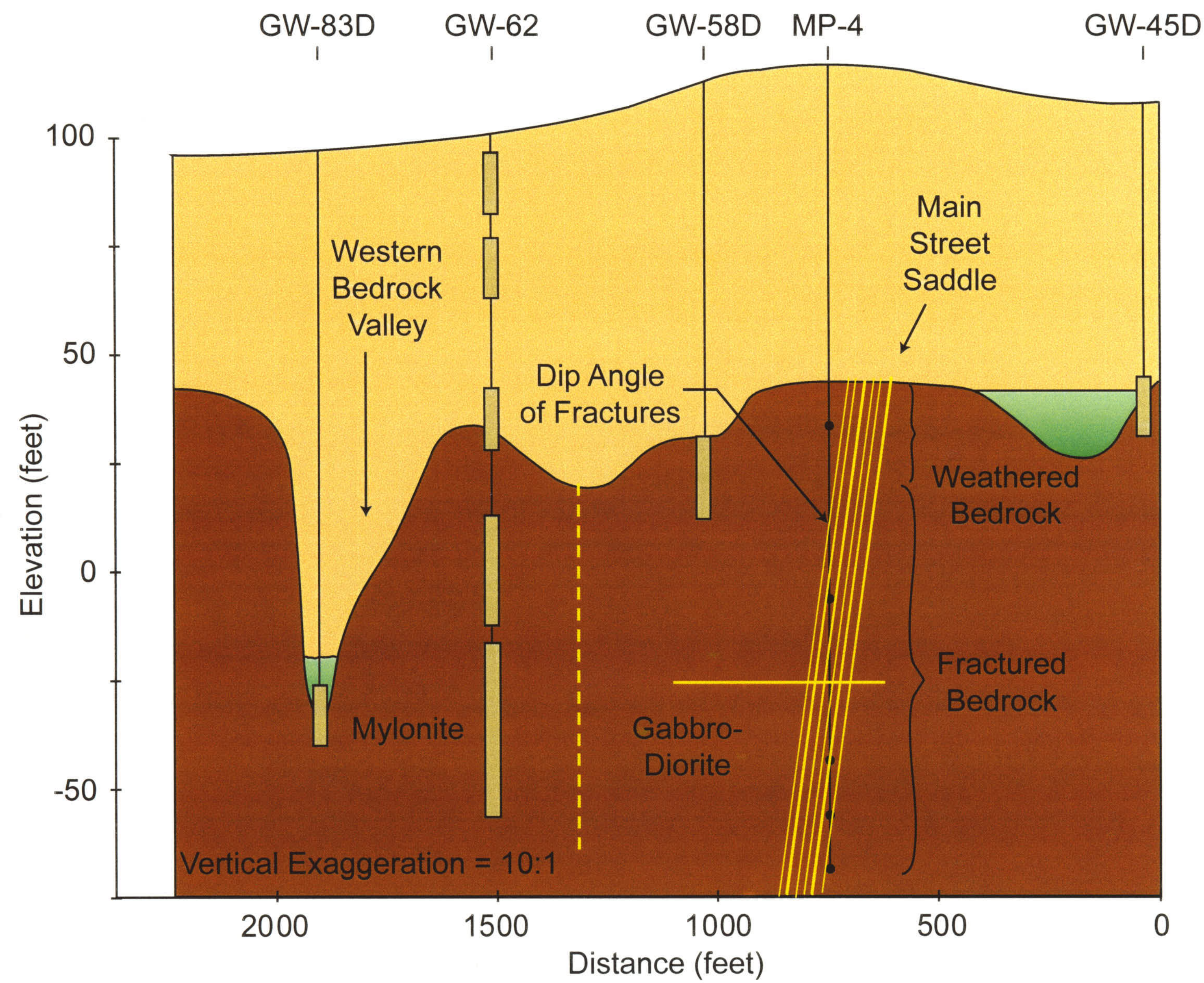
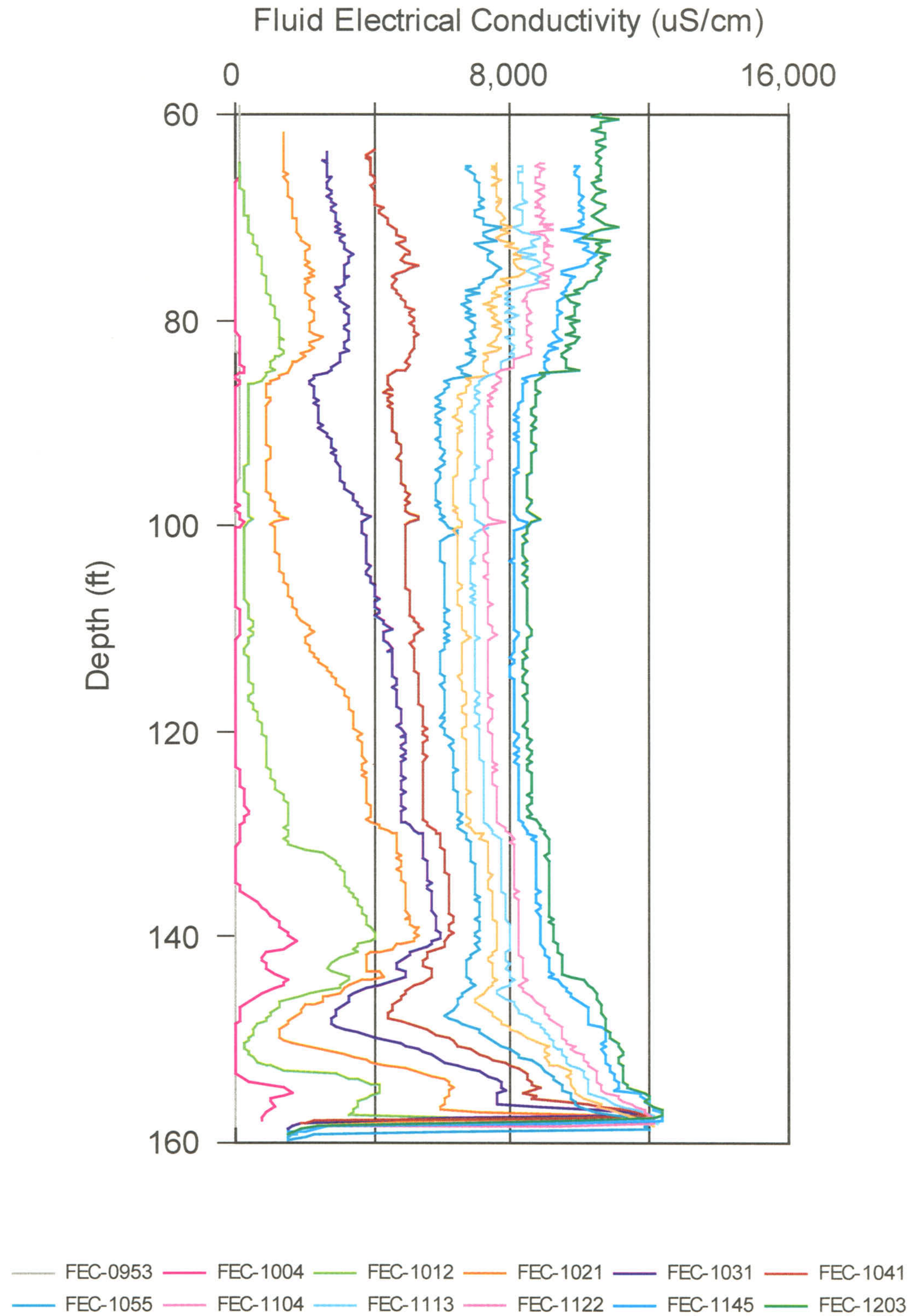


Generation Date: 12/18/01	Figure 9. Fracture orientation in MP-4 and relationship to WBV.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\fracture orientation.ai



Generation Date: 12/18/01	Figure 10. Hydrophysical log of SB-8.	Geomega

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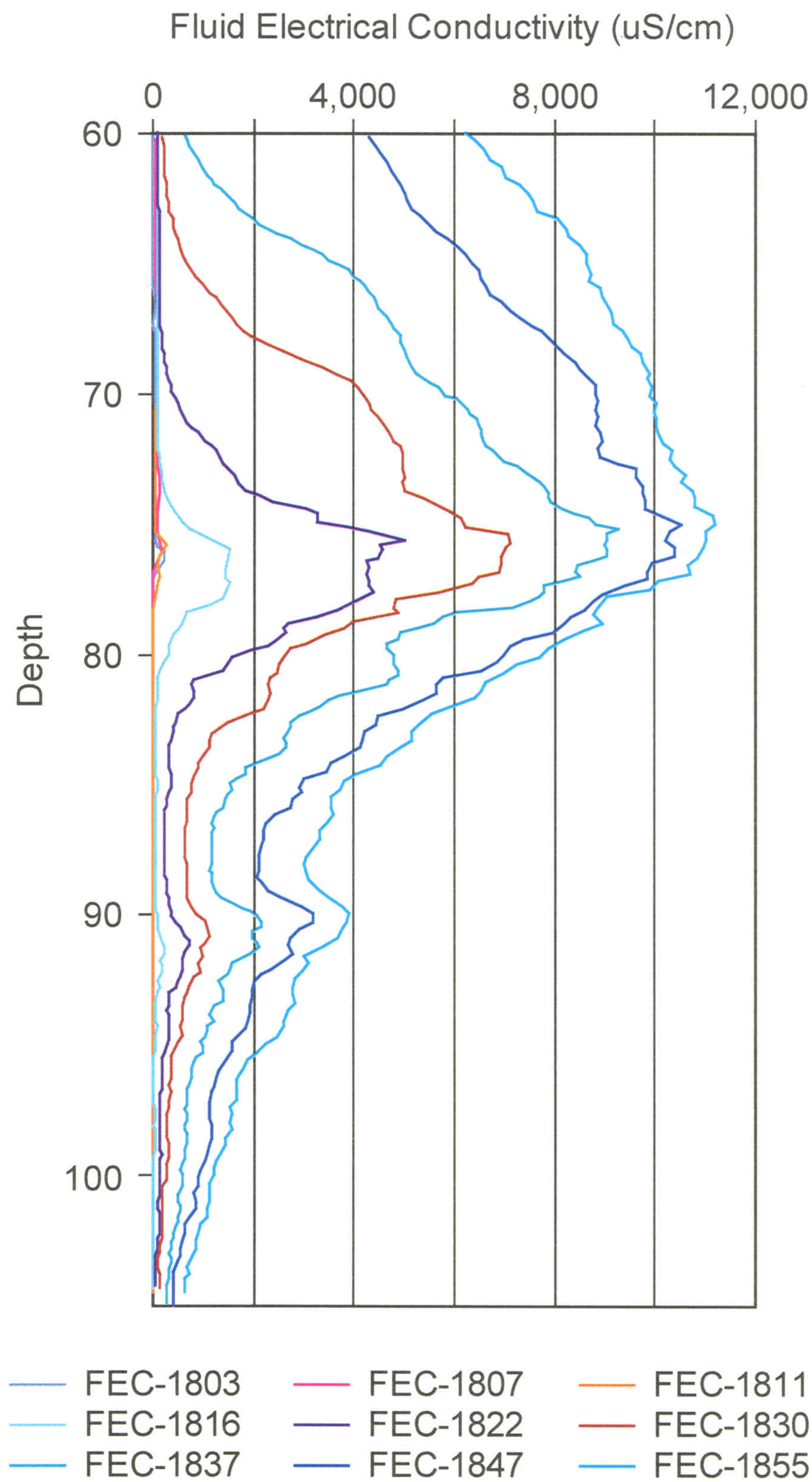

Generation Date: 12/18/01	Figure 11. Hydrophysical log of GW-62BR.	Geomega

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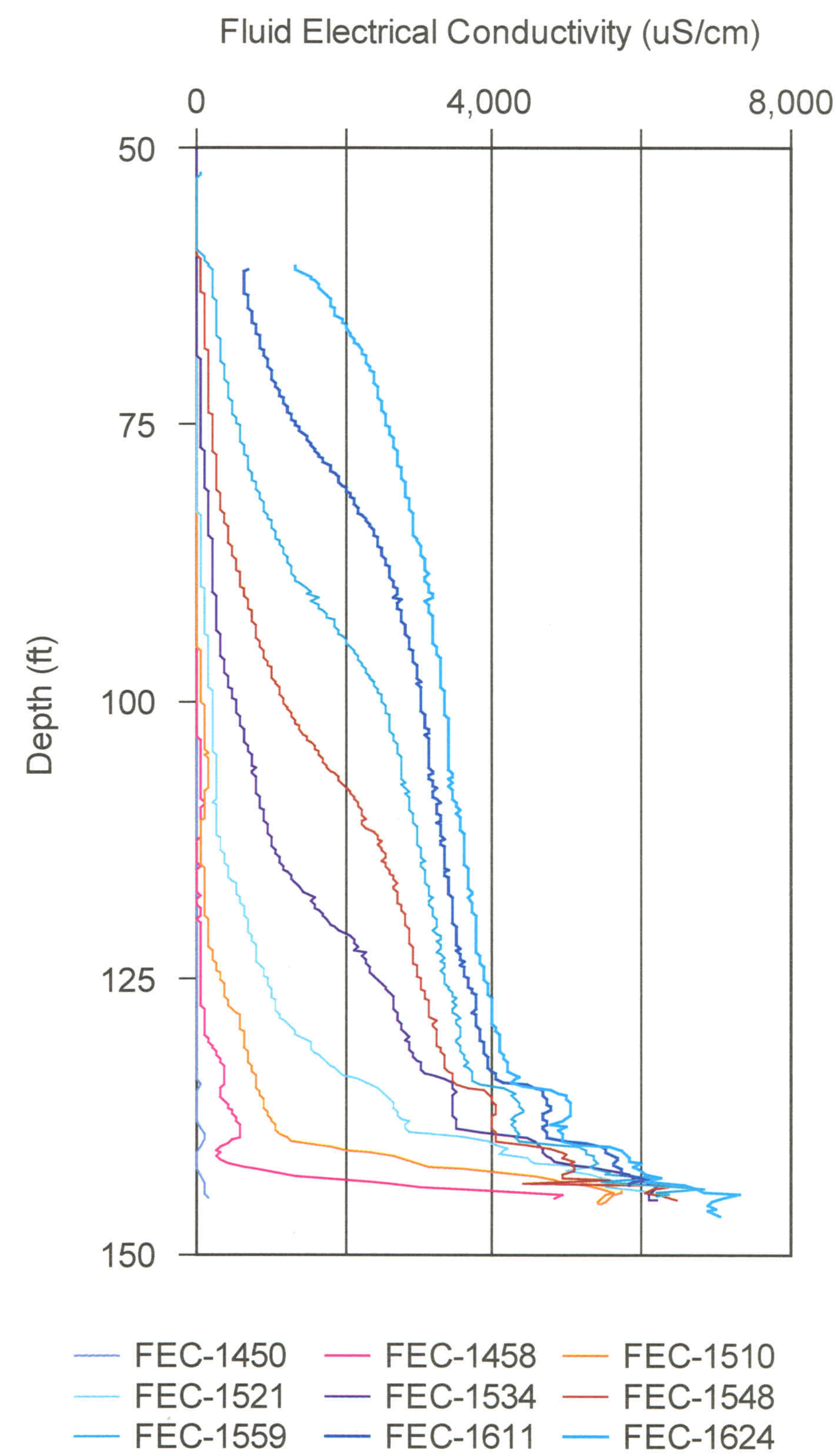
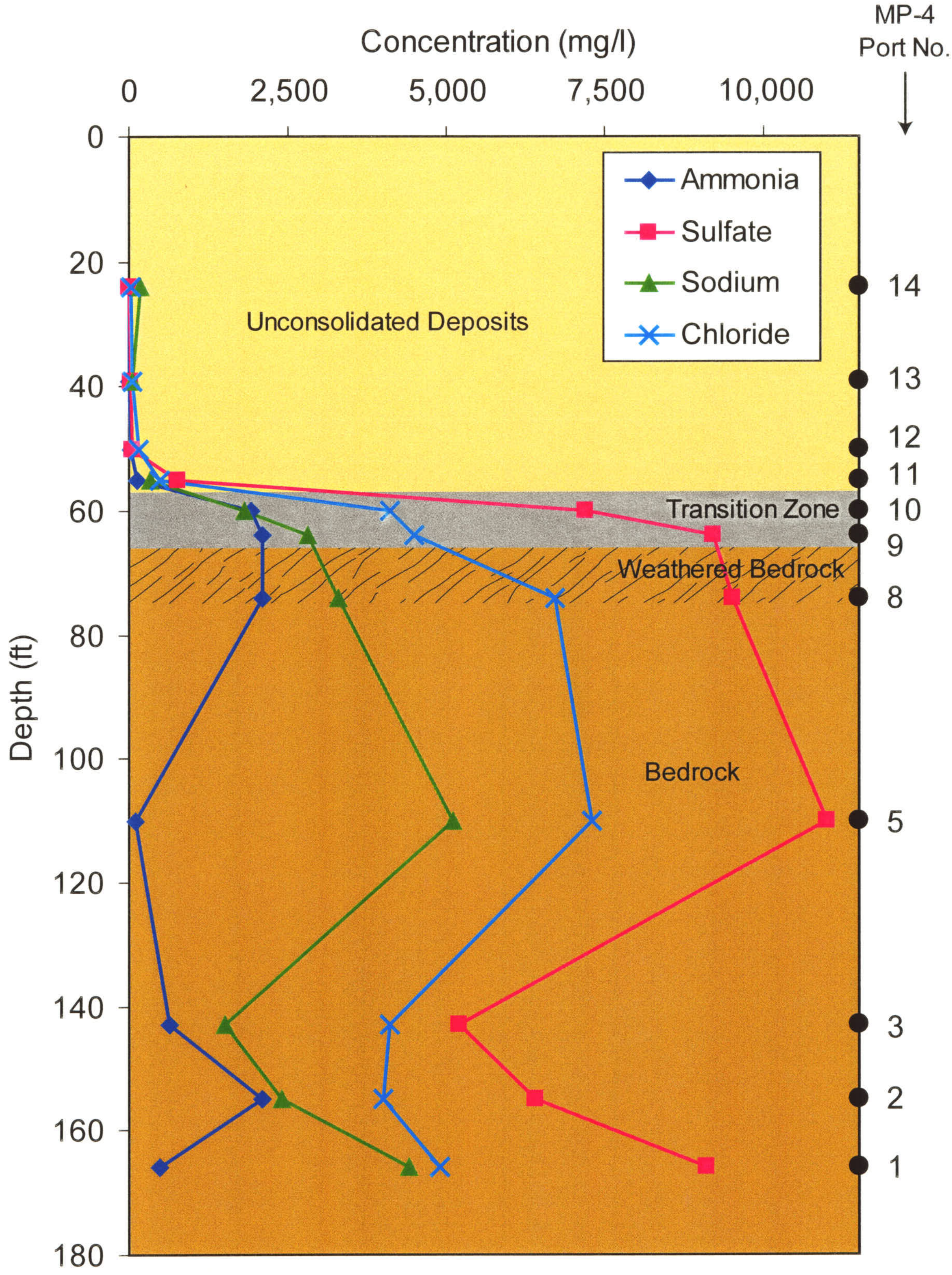


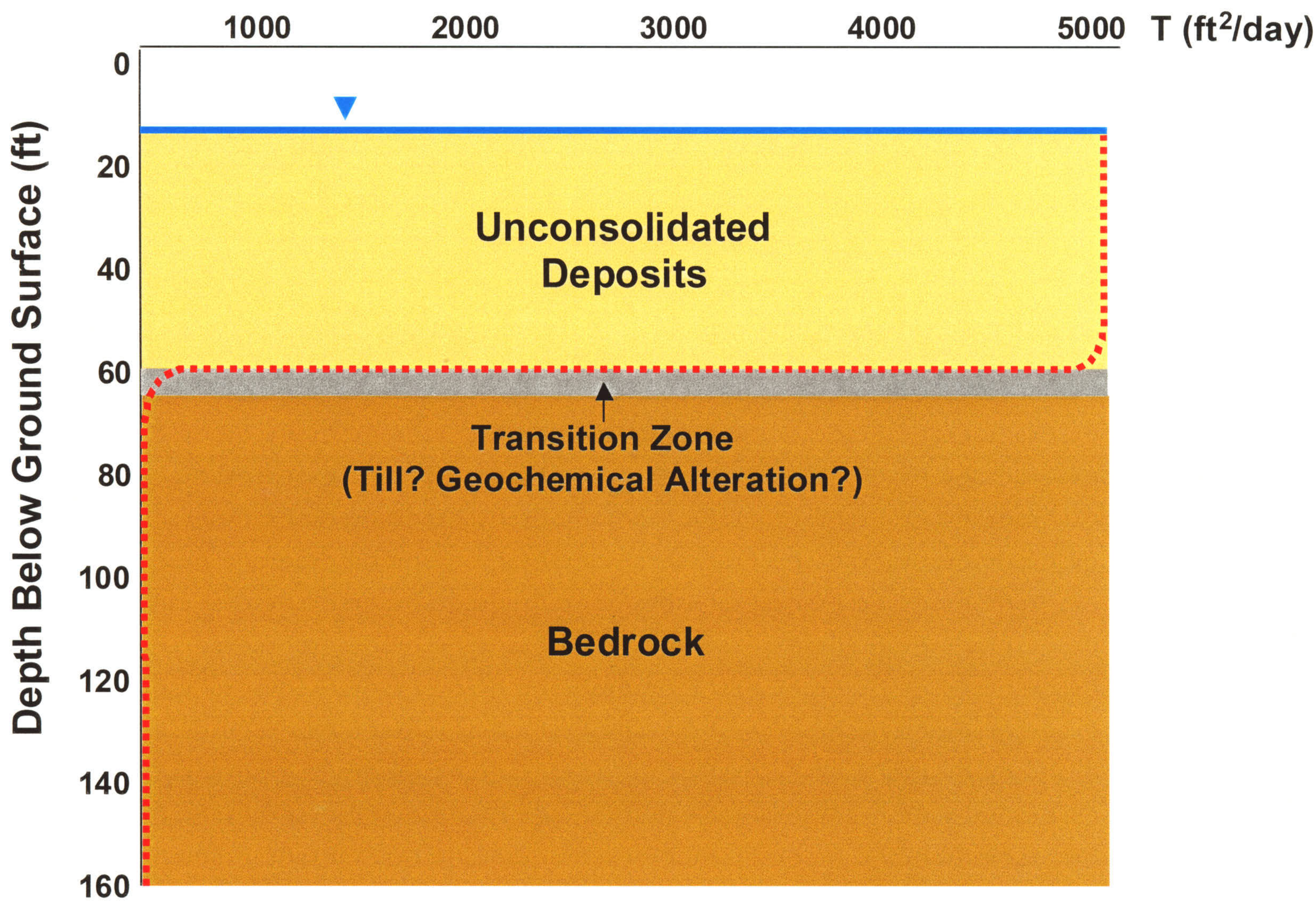
Generation Date: 12/18/01	Figure 12. Hydrophysical log of GW-62BRD.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\GW-62BRD.ai



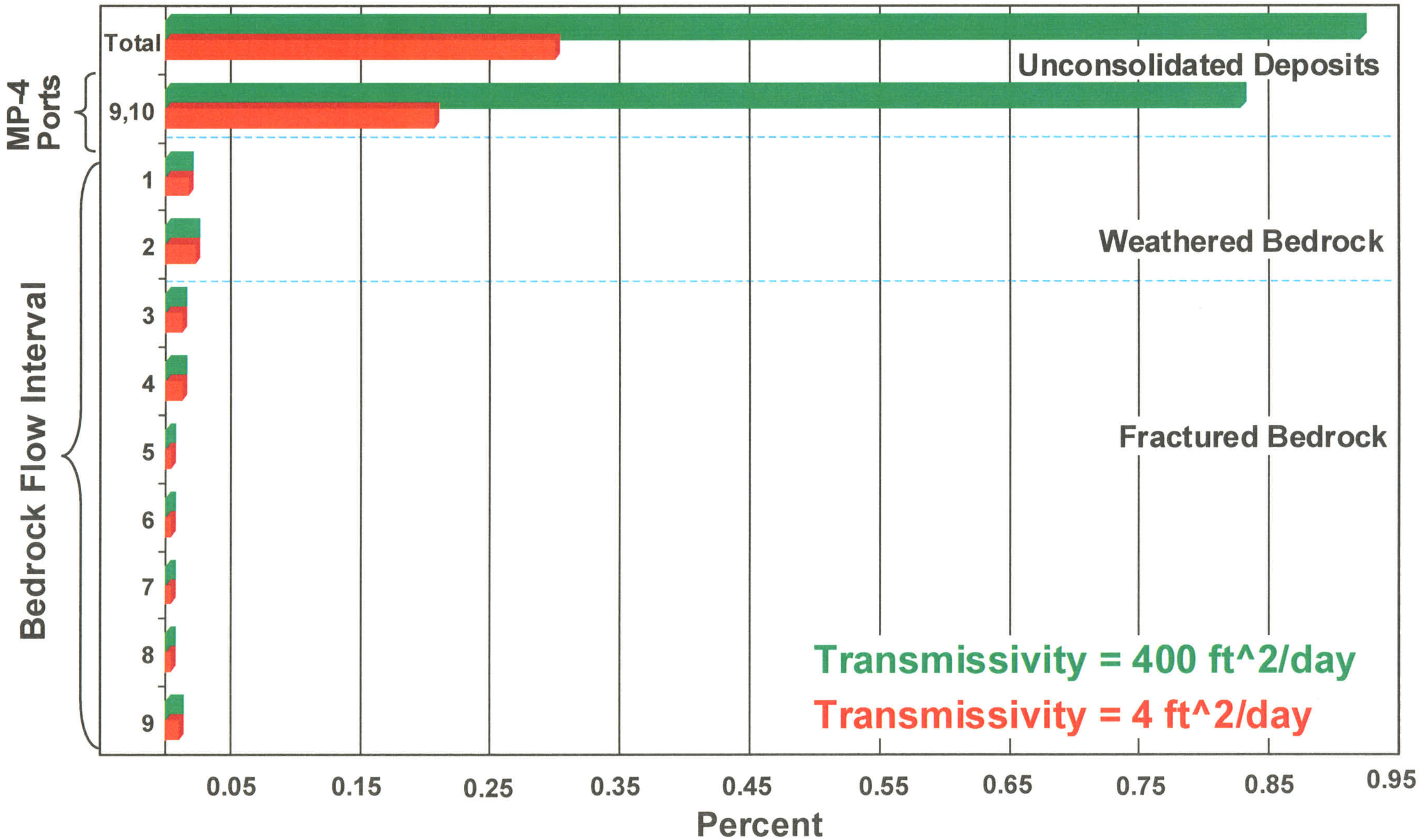
Generation Date: 12/18/01	Figure 13. MP-4 concentration profiles of major DAPL constituents.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\Profiles.ai



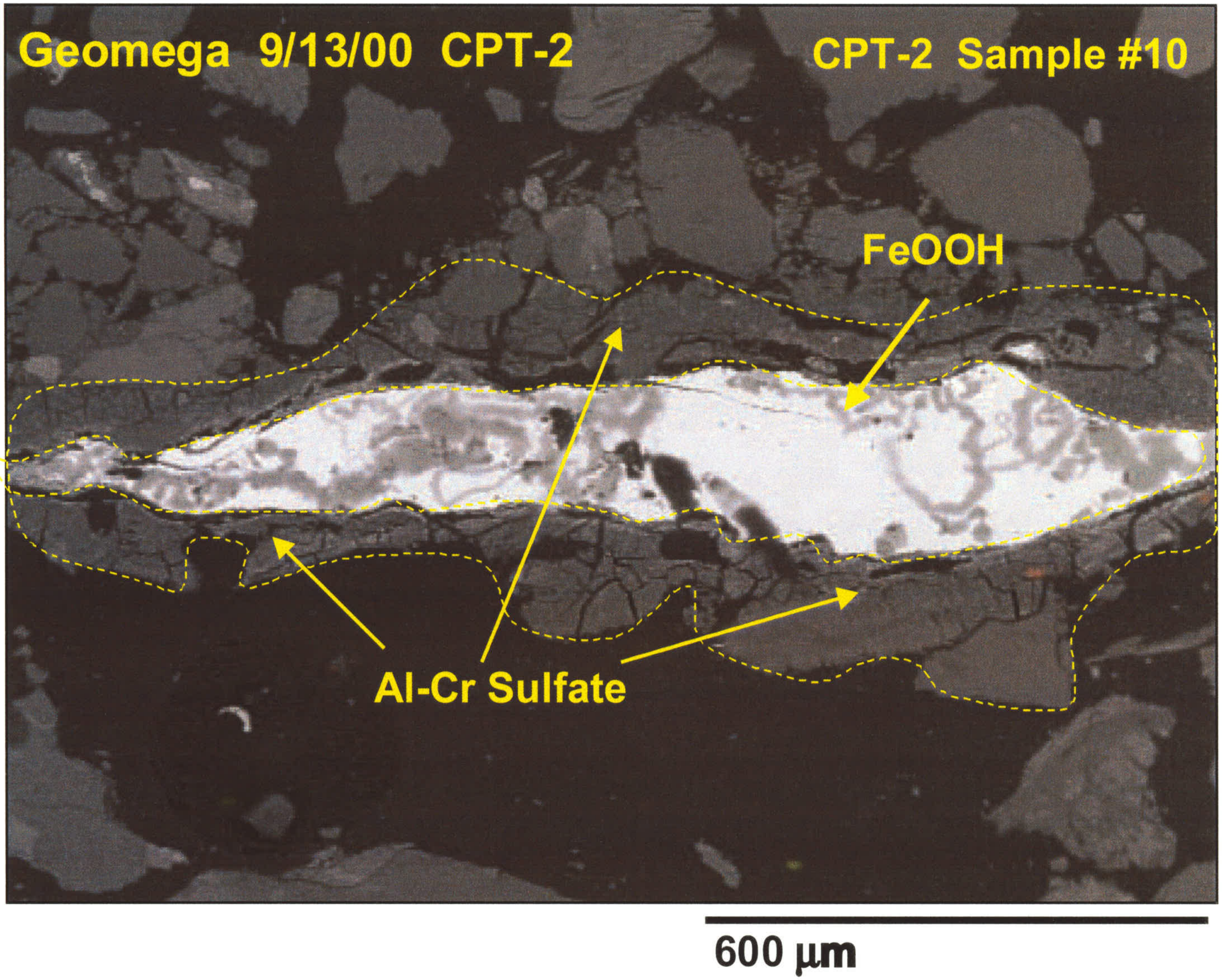
Generation Date: 12/18/01	Figure 14. Transmissivity profile at MP-4.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\transmissivity profile.ai



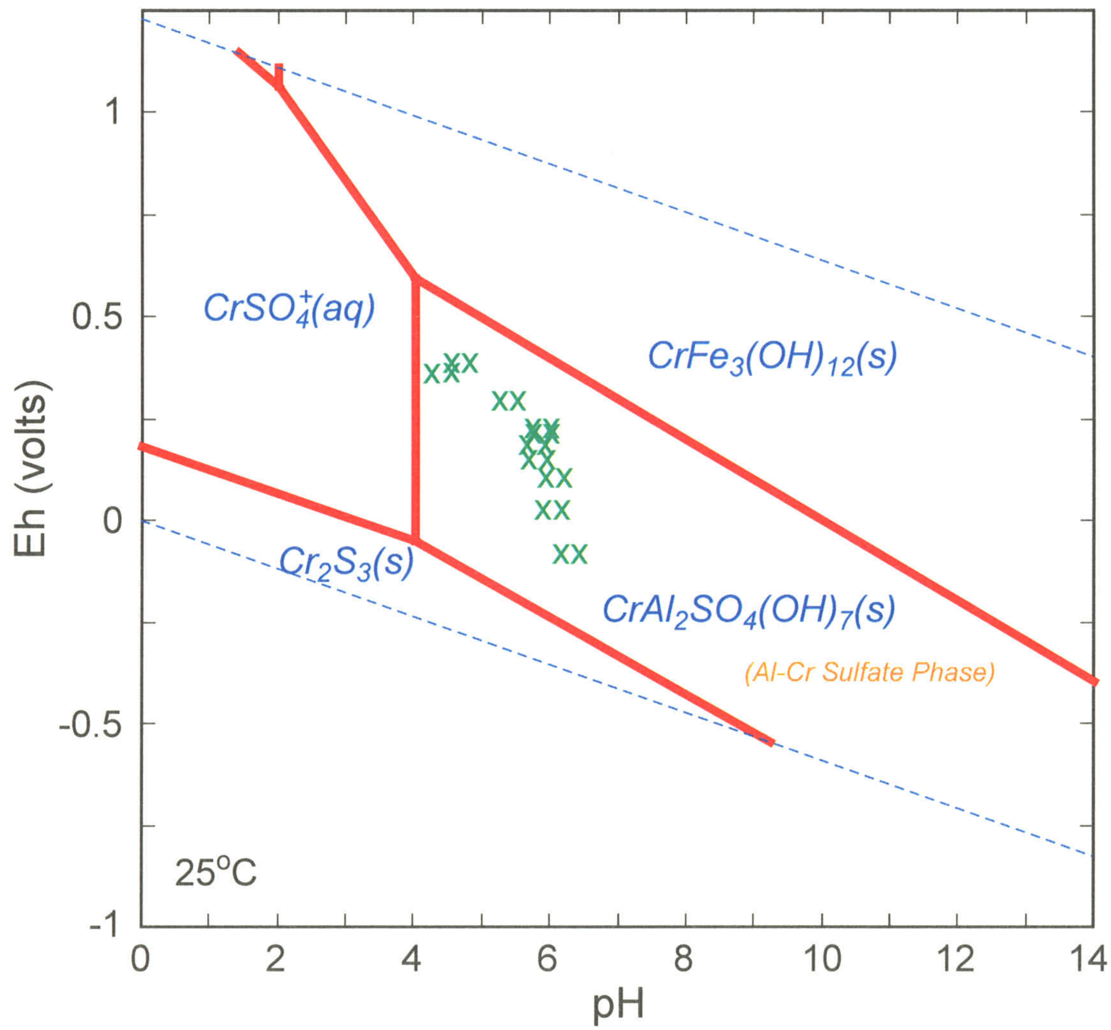
Generation Date: 12/18/01	Figure 15. Annual solute flux past saddle as percent of total DAPL mass.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\annual solute flux.ai



Generation Date: 12/18/01	Figure 16. Al-Cr sulfate phase identified in CPT-2.	Geomega

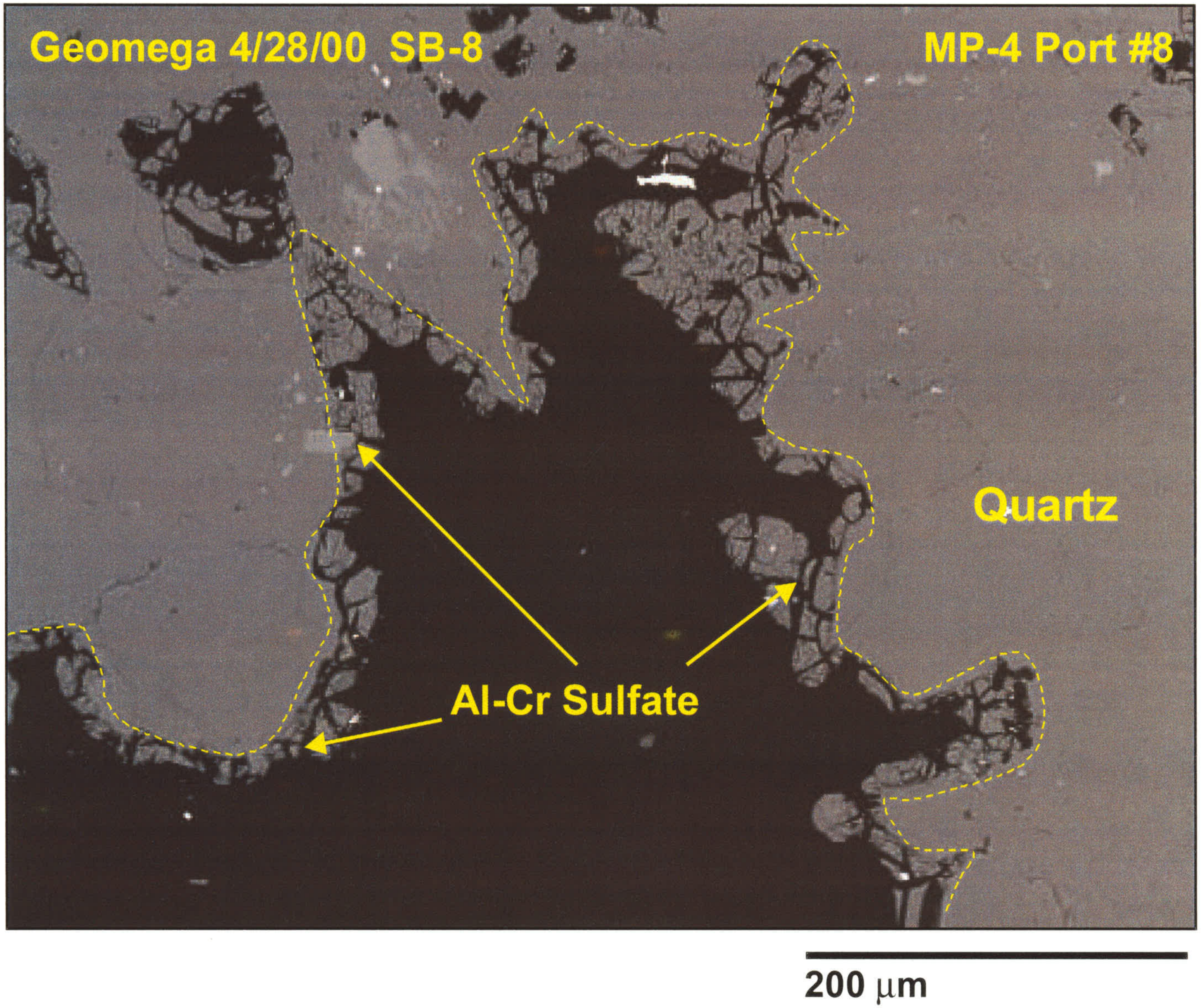
o:\Olin\Bedrock Saddle Report 12-01\Micro Al-Cr.ai



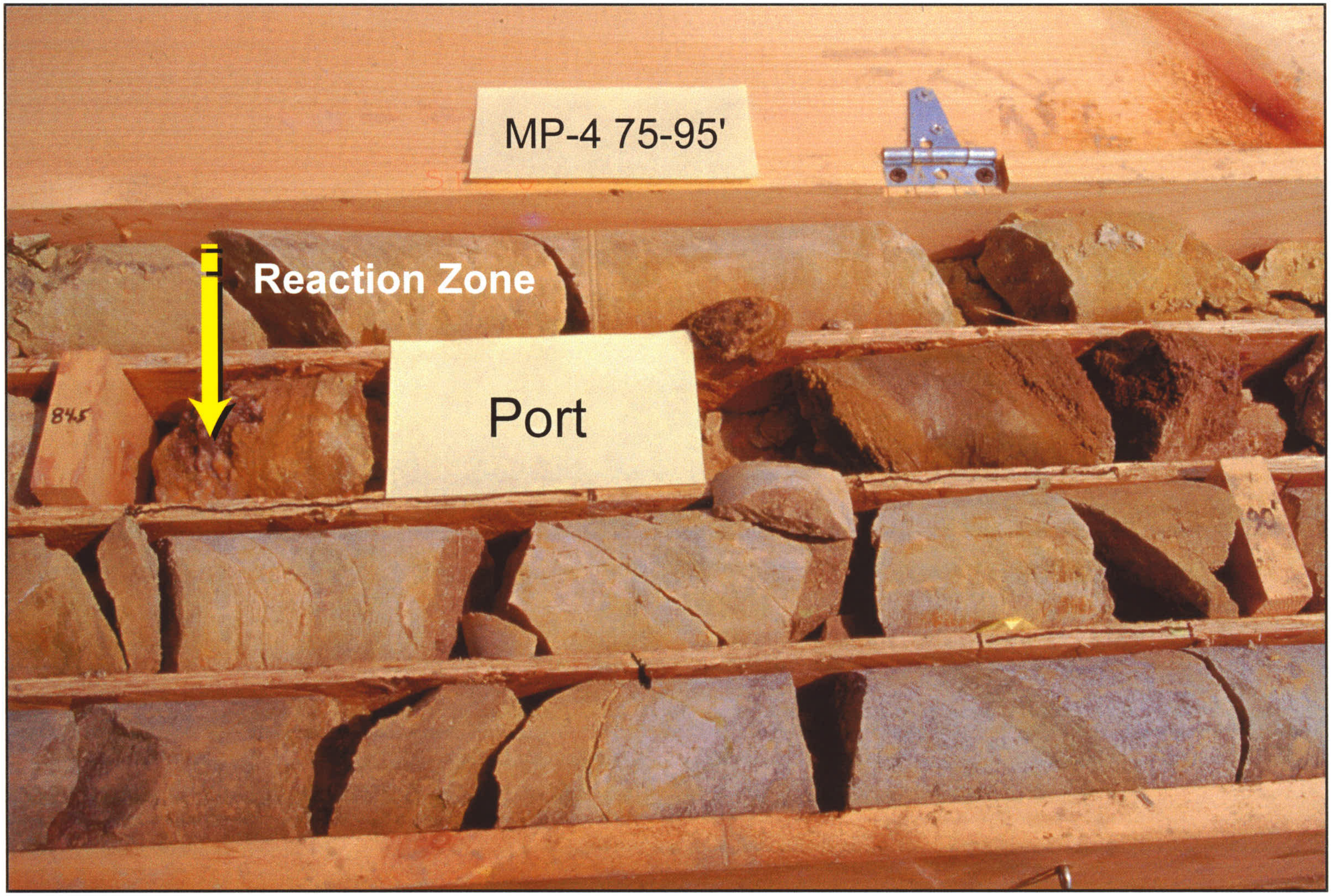
Note: Green crosses indicate measured Eh-pH conditions of waters from MP-4.

Generation Date: 12/18/01	Figure 17. Eh-pH diagram showing stability of Al-Cr sulfate phase in Olin Site groundwater.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\Eh-pH Al-CR.ai

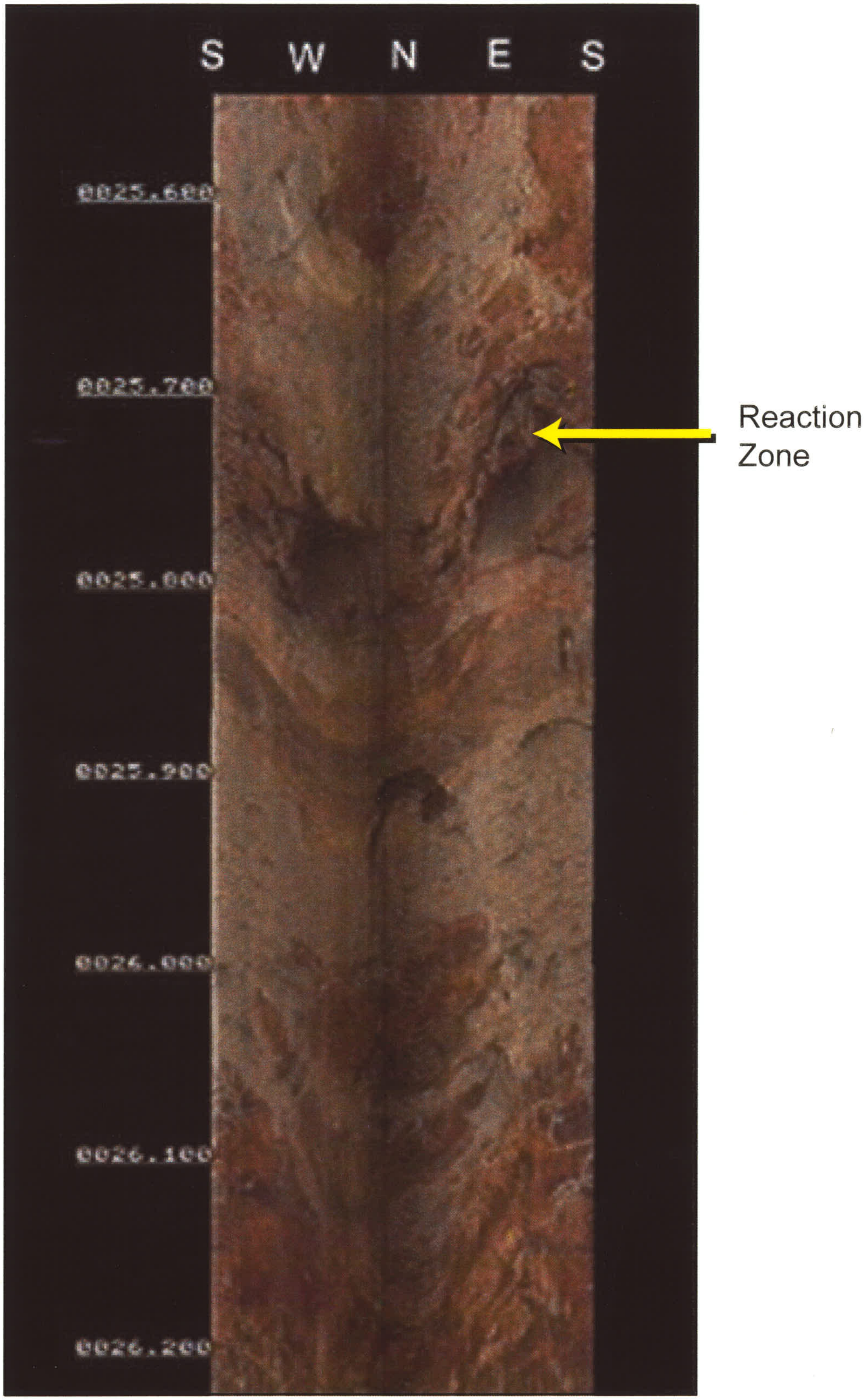


Generation Date: 12/18/01	Figure 18. Al-Cr sulfate phase identified in SB-8.	Geomega



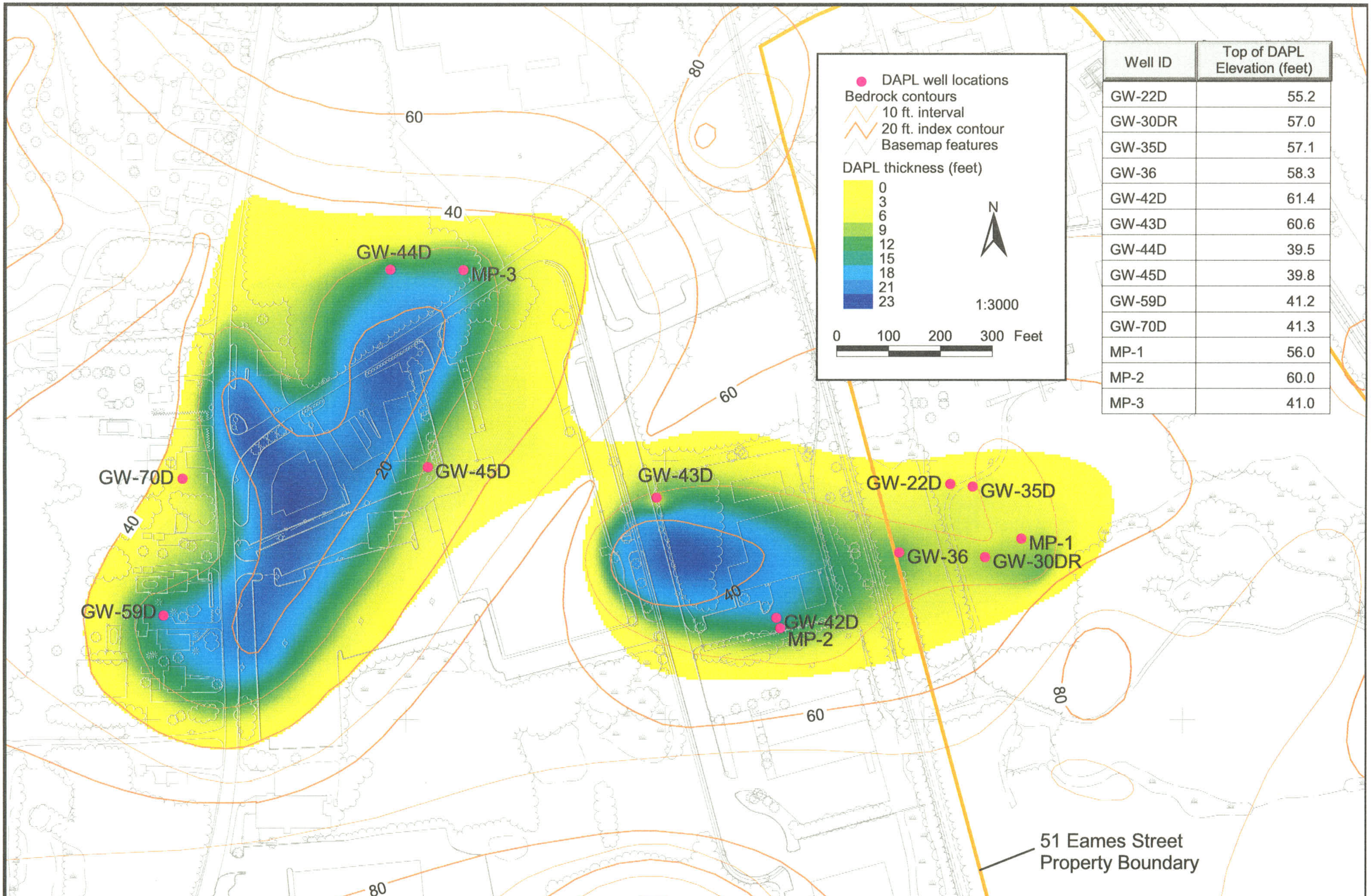
Generation Date: 12/18/01	Figure 19. The overburden - bedrock interface.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\Interface.ai



Generation Date: 12/18/01	Figure 20. SB-8 core at 84.5 feet bgs.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\MP-4 Wall.ai



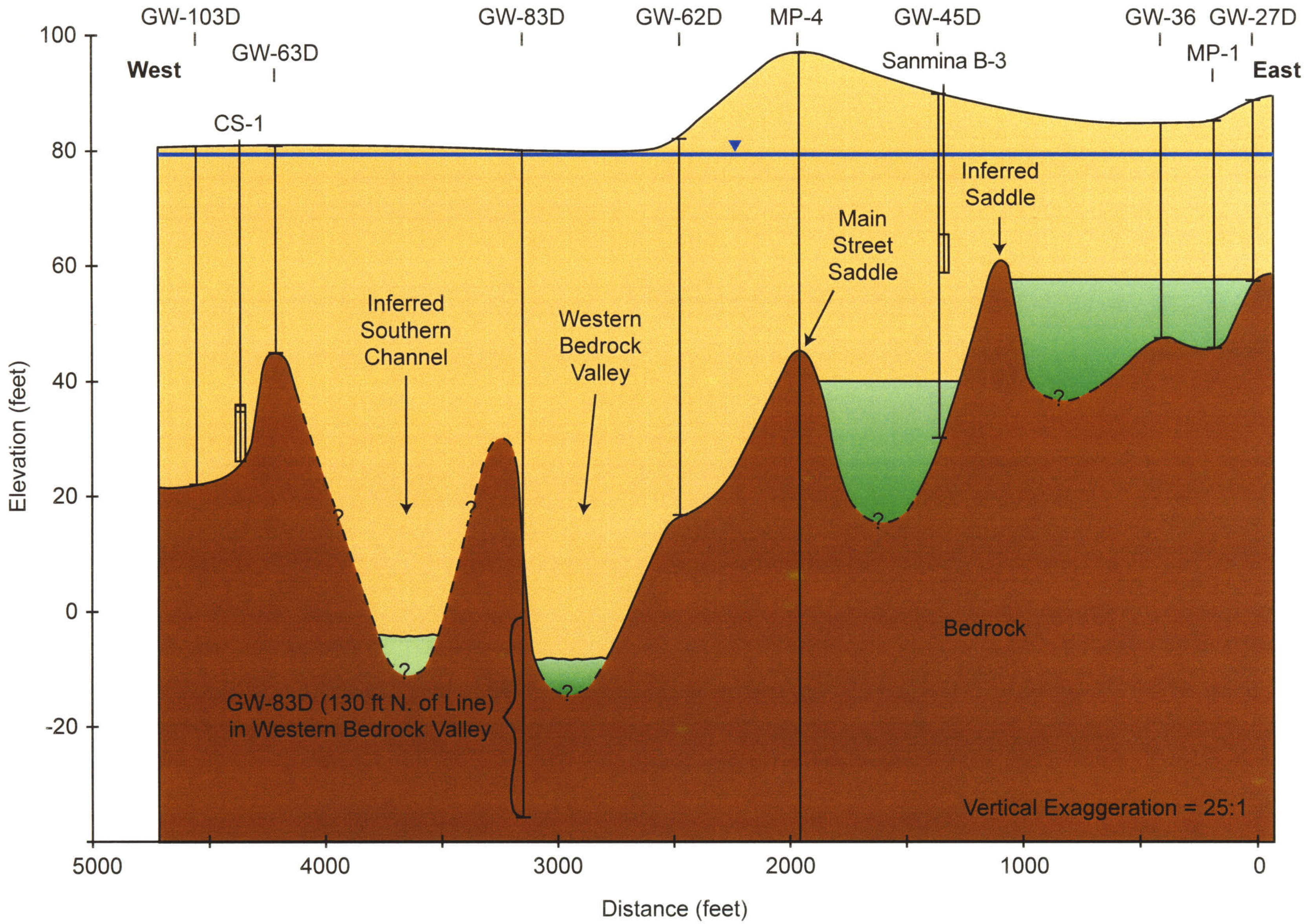
Well ID	Top of DAPL Elevation (feet)
GW-22D	55.2
GW-30DR	57.0
GW-35D	57.1
GW-36	58.3
GW-42D	61.4
GW-43D	60.6
GW-44D	39.5
GW-45D	39.8
GW-59D	41.2
GW-70D	41.3
MP-1	56.0
MP-2	60.0
MP-3	41.0

Generation Date: 4/17/01

Figure 21. Thickness and extent of DAPL in 2000

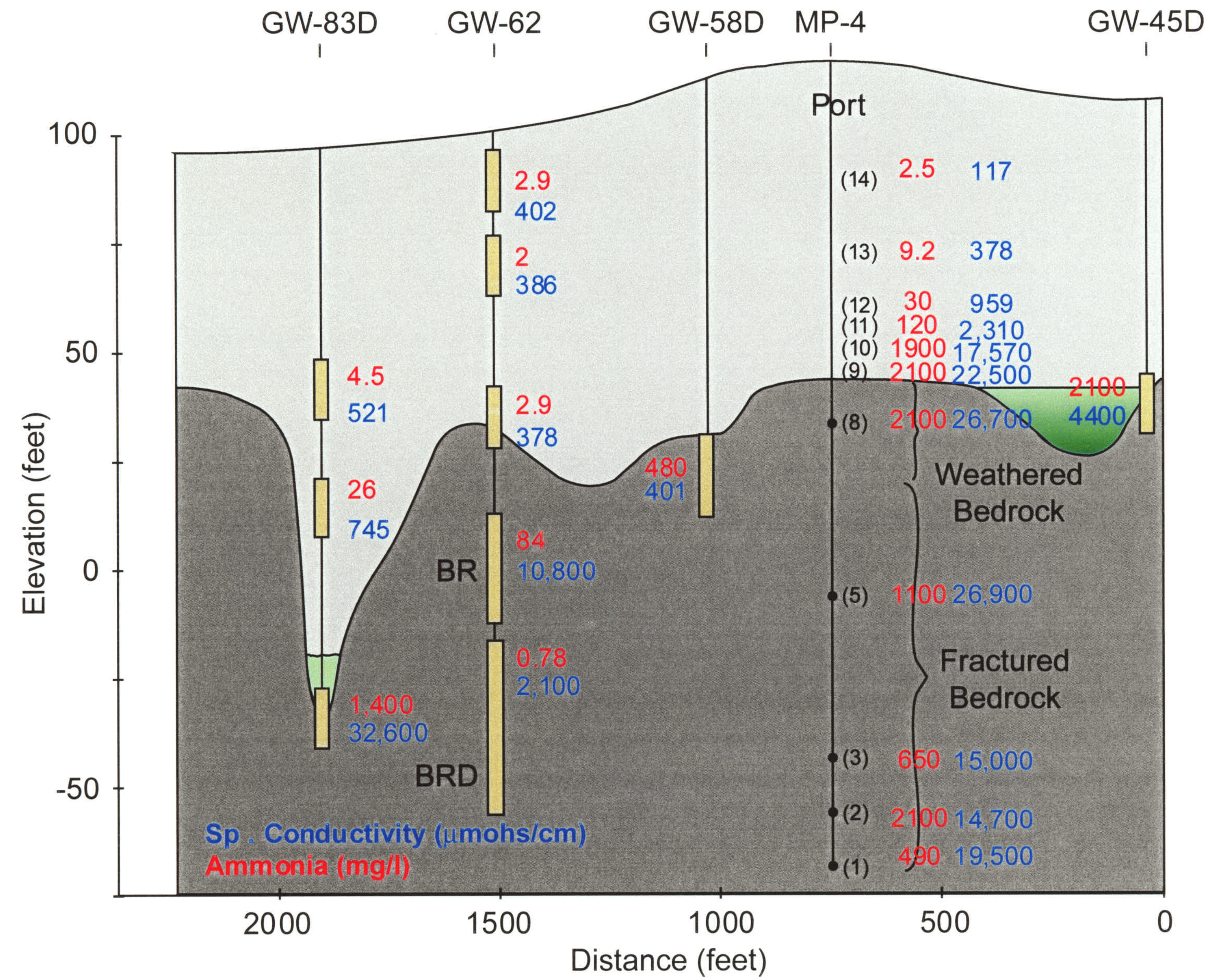
Geomega

\\y:\projects\olin\av-aprs\br060700.apr: DAPL thickness Layout



Generation Date: 12/18/01	Figure 22. East-west cross section showing bedrock depressions and saddles.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\X-sec Depressions.ai



Generation Date: 12/18/01	Figure 23. Indicator chemistry from Main Street Saddle to WBV.	Geomega

o:\Olin\Bedrock Saddle Report 12-01\indicator chemisrty.ai

Appendix A

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APR 1 3 1998

S.G. MORROW

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
METROPOLITAN BOSTON - NORTHEAST REGIONAL OFFICE

ARGEO PAUL CELLUCCI
Governor

TRUDY COXE
Secretary

DAVID B. STRUHS
Commissioner

APR 03 1998

Olin Corporation
P.O. Box 248
Lower River Road
Charleston, TN 37310
ATTN: Stephen Morrow

RE: WILMINGTON-
Olin Chemical
51 Eames Street
DEP RTN: 3-0471
Supplemental Phase II Investigation
Seismic Survey West of Main Street
Conditional Approval

Dear Mr. Morrow:

The Department of Environmental Protection (the Department) has received and reviewed a March 13, 1998 work plan entitled: "Supplemental Phase II Investigation, Seismic Survey West of Main Street". The work plan was prepared by GEI Consultants, Inc. (GEI) on behalf of Olin Corporation. The objective of the seismic survey is to supplement existing information regarding the depth and orientation of the bedrock surface, or other geologic features west of Main Street in Wilmington, which may influence the lateral extent and migration of the dense contaminant layer which extends from the Olin facility.

The plan proposes to complete two seismic survey lines, each 1,000 feet in length, which will trend east-west, perpendicular to Main Street. The approximate location of the lines is illustrated on Attachment A, which is the Top of Precambrian Bedrock Structure Map, taken from Appendix D of the Supplemental Phase II Investigation. The seismic survey locations proposed by GEI are shown as solid lines on this map. The seismic survey will consist of the placement of geophones along the length of the line and the detonation of a small amount of blasting agent or shot locations placed in hand-excavated boreholes, at a depth of 3 to 4 feet. Approximately 26 detonations will be performed along the seismic lines at intervals of about 150 feet.

Prior to performing field work, Olin will need to obtain permission from the property owners to enter each property within the study area from the property owners. In addition, Olin will need to obtain approval from the Wilmington Conservation Commission to complete work within the vegetated wetland.

The results of the seismic survey will be summarized in a letter report to the Department within 90 days of the Department's authorization of this Scope of Work. The letter report will contain a summary of work performed, maps delineating the location of seismic lines, and revised estimates of the depth and orientation of the bedrock surface west of Main Street.

CONDITIONS OF APPROVAL

As we discussed at a meeting on March 31, 1998, in order to more thoroughly define the bedrock surface west of Main Street, the Department requires the completion of three additional seismic survey lines, the locations of which are illustrated as dashed lines on Attachment A. The first line will be approximately 1,100 feet in length, and will trend southeast-northwest from near monitoring well GW-59D to near monitoring well GW-62D. The bedrock ridge between these wells has not been documented with previous geophysical or soil boring data. The second and third seismic lines will each be approximately 600 feet in length, and will follow the bedrock ridge which is reported to separate the upper and lower western bedrock valleys.

The Department also requires the completion of one additional seismic line to define the bedrock valley located in the vicinity of the Chestnut Street Wells. This bedrock valley is the likely pathway for inorganic contaminants, such as ammonia, chloride, sodium, and sulfate, to migrate with groundwater toward the wellfield. The concentrations of these inorganic contaminants increased by fifty percent or more after a second Chestnut Street Well was brought on line in September 1992. The location of the proposed seismic line is identified on Attachment A. The seismic line will be approximately 1,400 feet in length and will trend northeast-southwest from monitoring well GW-87 to monitoring well CB-3.

GEI will complete the two seismic lines proposed in the original work plan first, and submit a letter report to the Department which evaluates the data. While this work is being completed GEI should obtain permission to enter each property within the additional study areas listed by the Department, as well as obtain approval from the Wilmington Conservation Commission to complete the additional work requested within the vegetated wetland. The Department acknowledges that the locations and/or lengths of the additional seismic lines may need to be revised based upon information obtained from the letter report and property access considerations.

The bedrock information generated from the seismic investigations shall be used to revise the Top of Precambrian Bedrock Structure Map, completed by Raypath, Inc., in December 1996, and submitted to the Department for review.

The Department hereby grants approval of your work plan, contingent upon your acceptance of the conditions outlined above, and your adherence to the provisions of all applicable DEP Policies governing response actions under the Massachusetts Contingency Plan. Your initiation of the approved activities will constitute your understanding and acceptance of this approval.

If you have any questions concerning this letter, please contact Christopher Pyott at (781) 932-7739 or the letterhead address.

Very truly yours,

Christopher J. Pyott

Christopher J. Pyott
Environmental Analyst

Stephen M. Johnson

Stephen M. Johnson
Section Chief, Site Management
Bureau of Waste Site Cleanup

cc: Wilmington BOH
Data entry/file
DEP/NERO/Water Supply ATTN: Jim Persky
Smith Technology Corporation, One Plymouth Meeting, Plymouth Meeting, PA 19462, Attn: Bruce Cushing
GEI Consultants, Incorporated, 1021 Main Street, Winchester MA 01890-1970, Attn: M. Margret Hanley
Law Environmental Consultants, Incorporated, 3 Corporate Plaza, Washington Avenue Extension, Albany, NY 12203 Attn: Michael Patenaude

Attach t

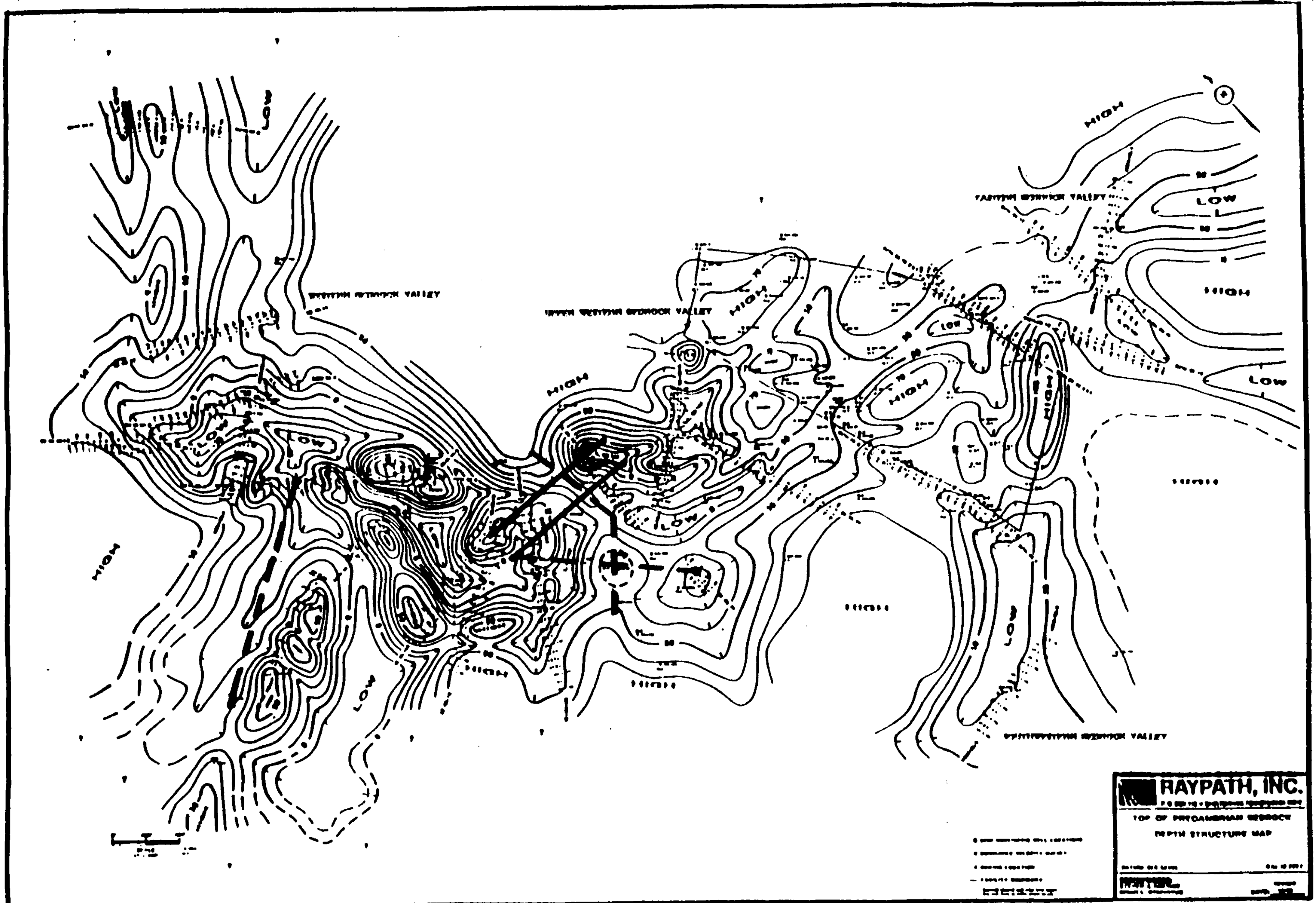

Figure 2

GEI Consultants, Inc. - Proposed Seismic Lines

Department of Environmental Protection -
Additional Proposed Seismic Lines

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
METROPOLITAN BOSTON - NORTHEAST REGIONAL OFFICE

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OCT 1998

ARGEO PAUL CELLUCCI
Governor

TRUDY COXE
Secretary

DAVID B. STRUHS
Commissioner

cc: WICA
SITE TEAM
FOR OCT 9
PRODUCTI...

OCT 02 1998

Olin Corporation
P.O. Box 248
Lower River Road
Charleston, TN 37310
ATTN: Stephen Morrow

RE: WILMINGTON-
Olin Chemical
51 Eames Street
DEP RTN: 3-0471
Comprehensive Groundwater Monitoring Program Review

Dear Mr. Morrow:

The Department of Environmental Protection (DEP) has reviewed a report for the subject site entitled: "Groundwater Monitoring Report: Western Bedrock Valley and Sentinel Well Groundwater Monitoring Programs" dated January 1998. The report was jointly prepared by BCM Engineers, Inc. and GEI Consultants, Inc., on behalf of the Olin Corporation (Olin). In addition DEP has reviewed memos completed by Geomega dated July 22, 1998 and September 16, 1998. The memos discussed historical water quality data that has been collected at the Wilmington Supply Wells, and the potential for migration of the dense contaminant layer and dissolved phase inorganic contamination through the Western Bedrock Valley and the bedrock. The findings and recommendations of the report are highlighted below.

OLIN'S COMPREHENSIVE GROUNDWATER MONITORING PROGRAM FINDINGS

- The existing monitoring well network provides a comprehensive picture of the groundwater quality in the Maple Meadow Brook Aquifer.

- The results of the Western Bedrock Valley and Sentinel Well Groundwater Monitoring Programs show that the highest concentrations of indicator parameters were detected in the deep wells; however, the high concentrations of contaminants in deep groundwater do not appear to be migrating into the shallower portions of the aquifer.

- The evaluation of data has shown that concentrations of indicator parameters are cyclical and that higher concentrations appear to correspond with higher town well pumping rates and/or drier periods when the aquifer has less saturated thickness. These seasonal variations and the preponderance of historical data from periods with "seasonally lower" concentrations makes it difficult to use historical data to identify long term trends in concentrations. However, the increases in the maximum observed concentrations of chloride at Chestnut Street Well #1 (CSW1) and ammonia at the Butters Row Wells (BRW's) may be indicative of trends that could be defined by further monitoring.

OLIN'S COMPREHENSIVE GROUNDWATER MONITORING PROGRAM RECOMMENDATIONS

- Monthly sampling is recommended for the following monitoring wells and town supply wells, because they are completed in the portion of the aquifer which is likely to contribute the greatest mass of contaminants to the town supply wells:

GW-63D	GW-85M/D
GW-64S/D	GW-86M/D
GW-65D	Butters Row 1 and 2
GW-73D	Chestnut Street and 2/1A
GW-83M	Town Park

- Annual sampling is recommended for the following deep monitoring wells to monitor the higher concentrations of parameters in the deep groundwater and the dense layer:

GW-62D	GW-84D
GW-83D	GW-87D

- The evaluation of data has indicated that some of the ammonia and chloride detected in groundwater samples from the town wells and shallow monitoring wells may be related to other sources. Some of the ammonia could be from increases in ammonia concentrations in soils which occurs after flooding of the wetlands when oxygen depletion and nitrogen reduction occur. Some of the chloride could potentially be attributed to surface water runoff which contains chloride from road salt application. The collection and analysis of two surface water and four groundwater samples for indicator parameters will be conducted to quantify potential inputs of these parameters from surface sources. Two piezometers will be installed immediately below the organic muck in the wetlands and will be sampled at approximately 1 week and at 30 days after seasonal flooding of the wetlands in the fall. A surface water sample will be collected in the fall to establish background levels of indicator parameters, and an additional surface water sample will be collected after a significant snowfall has melted to determine the levels of chloride in surface water runoff that is contributed by road salt application.

- The monitoring program will entail the collection of filtered groundwater samples from the municipal supply wells and monitoring wells. The samples will be analyzed for the parameters listed below:

Alkalinity	Calcium
Ammonia	Chromium
Bicarbonate	Iron
Carbonate	Magnesium
Chloride	Potassium
Sulfate	Sodium
Temperature	Specific Conductivity
Ph	Total Dissolved Solids

- Monitoring of groundwater elevations will be completed at the following wells:

Monitoring Wells Near Production Wells

GW-63D	GW-63S	GW-64D
GW-64S	GW-65BR	GW-65D
GW-65S	GW-73D	GW-73S

Monitoring Wells in Maple Meadow Brook

GW-82D	GW-82S	GW-83D
GW-83M	GW-83S	GW-84D
GW-84M	GW-84S	GW-85D
GW-85M	GW-86D	GW-86M
GW-86S	GW-87D	MMB-SG1-(gw)
MMB-SG1(sw)	MMB-SG2(sw)	MMB-SG3-(sw)
MMB-SG4(sw)		

Monitoring Wells Near Maple Meadow Brook

GW-60D	GW-60S	GW-61BR
GW-61D	GW-61S	GW-62BR
GW-62BRD	GW-62D	GW-62M
GW-62S	GW-66D	GW-66S
GW-71D	GW-71S	

Monitoring Wells in Uplands

GW-44D	GW-44S	GW-45D
GW-45S	GW-46D	GW-57D
GW-58D	GW-58S	GW-67D
GW-67S	GW-70D	GW-70S

In addition, continuous groundwater elevation monitoring will be conducted at GW-83M and GW-85M to determine how the pumping of town wells at variable rates affects groundwater elevations and gradients between these wells.

- GW-63D is located on a bedrock high and does not appear to be completed at an elevation that monitors the deeper, more contaminated groundwater that may be flowing toward CSW1. Future monitoring and data evaluations should determine if an additional deep monitoring point is needed to monitor for potential water quality changes at the Chestnut Street supply wells.

- Future data evaluations will consider using pumping data with greater resolution, such as average daily or average weekly rates, because monthly pumping rates do not reflect the periods during the month when supply wells were off-line or pumping at a rate that would be significantly higher or lower than the average pumping rate. This may provide a better understanding of short-term variations in indicator parameter concentrations and improve predictive models.

- Further data evaluations will attempt to resolve the relationship between precipitation and town well indicator parameter concentrations.

DEP REVIEW/COMMENTS

DEP has reviewed historical water quality data for BRW1, CSW1, and the Town Park Well. Results of this investigation revealed that ammonia and sulfate migrating from the Olin site show trends of increasing concentration over time in BRW1 and CSW1. The trends are not statistically significant in BRW1, and may not be indicative of further migration of contamination toward the wellfield. The trends are statistically significant in CSW1, but may only be due to increased pumping from this portion of the aquifer. However the Western Bedrock Valley and Sentinel Well Groundwater Monitoring Programs must be modified in order to collect additional data to clearly understand the migration of dissolved phase inorganic contamination, as well as the potential migration of the dense contaminant layer, through the aquifer which underlies Maple Meadow Brook.

DEP's data analysis focused on: 1) Historical water quality data collected from BRW1, CSW1, and the Town Park Well; 2) potential for migration of the dense contaminant layer and dissolved phase inorganic contamination through the Western Bedrock Valley; and 3) the potential for the migration of the dense contaminant layer and dissolved phase inorganic contamination through bedrock fractures.

<u>Historical Water Quality Data Evaluation - Wilmington Town Wells</u>

Changes in ammonia and sulfate concentrations in groundwater samples collected from the Wilmington Maple Meadow Brook Aquifer Wells were evaluated using linear regression analysis, and compared to mean monthly town well pumping rates. Table 1 lists concentrations of ammonia and sulfate from April 1986 through April 1998, and Table 2 lists mean monthly pumping rates from January 1989 through June 1997. Figure 1 and Figure 2 depict changes in ammonia concentrations over time for all historical data recorded, and for samples collected only in the spring, respectively. Figure 3 and Figure 4 depict changes in sulfate concentrations over time for all historical data recorded, and for samples collected only in the spring, respectively. Figure 5 depicts changes in the mean monthly town well pumping rates over time.

Figures 1 and 2 show that ammonia and sulfate concentrations have remained relatively stable in TPW over the last 12 years. The mean ammonia and sulfate concentrations from 1986 through 1998 in TPW were 0.24 mg/l and 33.0 mg/l, respectively. The mean monthly pumping rate was 49 gallons per minute (gpm). Results of groundwater samples collected from the TPW may be representative of background concentrations of various compounds in the aquifer beneath Maple Meadow Brook.

Figures 1 and 2 show that ammonia and sulfate concentrations show a potential trend of increasing concentration over time in BRW1. Mean ammonia and sulfate concentrations in BRW1 were 2.11 mg/l and 62.0 mg/l, respectively, in samples collected from March 1988 through September 1992.

These concentrations are well above the historical mean concentrations listed above for the TPW. The concentrations of ammonia and sulfate increased to 4.76 mg/l and 106.2 mg/l, respectively, from October 1993 through April 1998. The data indicates that BRW1 has been impacted by inorganic contamination migrating from the Olin property since as early as the late 1980's and probably much earlier, and the concentrations of these compounds may be increasing with time. Potential increases in concentrations may be attributed to the migration of dissolved-phase contamination from the dense contaminant layer with groundwater flow, and the high pumping rates in the BRW's. The average monthly pumping rate from January 1989 through June 1997 in the BRW's was 588 gpm.

Ammonia and sulfate concentrations show a statistically significant trend of increasing concentration with time in CSW1. From April 1986 though September 1992 concentrations in CSW1 were similar to those identified in TPW, with mean concentrations of 0.20 mg/l and 33.6 mg/l, respectively. The mean monthly pumping rate from January 1989 through December 1992 was 221 gpm. However, in samples collected subsequent to 1992 the mean concentrations of ammonia and sulfate in CSW1 increased to 2.56 mg/l and 80.6 mg/l, respectively. The increases in concentration over time may be attributed to the migration of dissolved-phase contamination from the dense contaminant layer with groundwater flow, and the increase in the volume of water pumped by the town from this portion of the aquifer since 1992, when a second town pumping well was installed on Chestnut Street. From January 1993 through June 1997 the mean monthly pumping rate from the CSW's combined was 465 gpm, which is more than twice as much water as was pumped from this area of the aquifer prior to 1993. Inorganic contamination from the Olin site is apparently being pulled into the capture zone of the CSW's.

It is important to note that concentrations of ammonia and sulfate were also found to show potential trends of increasing concentration with time in BRW1 and CSW1, when data was plotted only for the springtime (Figures 3 and 4). This data evaluation technique removes the effects of seasonal variation.

Potential Migration of Contamination - Western Bedrock Valley

The Supplemental Phase II Report, dated June, 1997 indicated that there was a possible subsurface geologic barrier to flow located just west of Main Street. Additional seismic investigations were completed in April, 1998, to confirm the existence of the subsurface barrier, and a revised bedrock topography map was submitted to DEP on May 15, 1998. The results of the additional seismic work did not provide evidence for a subsurface barrier to flow West of Main Street. Instead it showed that the Western Bedrock Valley slopes from higher points beneath the Olin property to bedrock lows located to the west near the BRW's; as a result, there is no evidence to date that indicates there is a physical barrier to prevent the migration of the dense contaminant layer through the Western Bedrock Valley.

In order to understand the potential for the migration of dissolved phase inorganic contamination from the dense contaminant layer toward the water supply wells, the concentrations of ammonia and sulfate were plotted for samples collected in January 1997 for wells located along the Western Bedrock Valley (Table 3 and Figure 6). At MW-86D, which is only 250 feet from BRW-1, the concentration of sulfate was 1,390 mg/l, which is more than five times the Secondary MCL of 250 mg/l for this compound.

Potential Migration of Contamination - Bedrock Fractures

A review of the limited data available for water quality in bedrock West of the Olin site indicates that bedrock fractures may provide potential pathways for the migration of contamination. The only bedrock wells that have been installed in the Western Bedrock Valley are MW-62BR and MW-65BR. The locations of these wells, along with postulated bedrock fault zones beneath the Maple Meadow Brook Aquifer are identified on Figure 7, which is taken from a report completed by Raypath, Inc. in December 1996. The map was completed using data collected from a seismic reflection survey. MW-62BR is located to the west of the dense contaminant layer, and MW-65BR is located near the BRW's.

A groundwater sample collected from MW-62BR on October 16, 1995 had a high sulfate concentration and a high conductivity. The concentration of sulfate was 4,400 mg/l, and the conductivity of the water was 12,190 umhos. The concentration of sulfate in a water sample collected on the same date from MW-58D, which is located in the dense contaminant layer was 3,600 mg/l, and the conductivity of the water was 901 umhos.

Bedrock fracture connections may exist between the upgradient and downgradient portions of the Western Bedrock Valley, because there was an increase in the concentrations of ammonia, sulfate, and in the conductivity of the groundwater in MW-65BR when the wellfield was pumped heavily during a drought in the late summer of 1995. A water sample was collected from MW-65BR during a non-drought period on December 18, 1996, and the ammonia and sulfate concentrations were 0 mg/l and 22 mg/l, respectively, and the conductivity of the water was 254 umhos. In a water sample collected on October 12, 1995, following the drought period, the concentrations of ammonia and sulfate increased to 0.42 mg/l and 200 mg/l, respectively, and the conductivity increased to 2,810 umhos.

APPROVAL OF MONITORING PROGRAM AND ADDITIONAL DEP REQUIREMENTS

DEP approves of Olin's Western Bedrock Valley and Sentinel Well Groundwater Monitoring Program recommendations; however, the following additional requirements must be incorporated into the Program:

- A soil boring program will be completed north of the intersection of Main and Eames Street to further define the Western Bedrock Valley and define the downgradient extent of the dense layer.

- Wells GW-63S and GW-63D are located over a bedrock high and GW-63D does not appear to be completed at an elevation that monitors the deeper, more contaminated groundwater that may be flowing toward CSW1. A shallow/deep well couplet must be installed over a bedrock low point near CSW1. The deep well must be completed and screened at the bedrock surface. Additional seismic work has been approved in the vicinity of the CSW's in order to better define the bedrock surface. This information should be used to propose an acceptable location for the new well couplet.

- All of the existing bedrock wells will be resampled and a report submitted to the DEP regarding the nature and extent of known contamination in the bedrock.

- A geophysical investigation must be completed in the Western Bedrock Valley to determine the degree of water-bearing bedrock fractures. Bedrock fractures could act as a pathway for the migration of the dense contaminant layer and dissolved phase contamination from the site to the wellfield.

- There are presently only three bedrock wells West of Main Street. The geophysical investigation should be used to pinpoint locations for additional bedrock wells, or an alternative method should be proposed to monitor the potential migration of the dense contaminant layer through bedrock fractures through the Maple Meadow Brook Aquifer.

- The Western Bedrock Valley and Sentinel Well Monitoring Programs must be modified as follows in order to determine the migration of dissolved phase contamination, and the potential migration of the dense contaminant layer from the site toward the wellfield:

  - A new well couplet must be installed near CSW1 as described above and monitored on a monthly basis;

  - Wells MW-65S, MW-73S, and MW-86S must be added to the monthly monitoring program in order to monitor shallow groundwater quality in the vicinity of the water supply wells;

  - MW-44D, MW-45D, MW-58D, MW-59D, MW-62BR, MW-65BR, MW-70D, and the new bedrock wells, must be added to the annual monitoring program; and

  - On an annual basis, the potential migration of the dense contaminant layer must be monitored and evaluated. Its thickness must be measured at all wells sampled, and its extent must be depicted on a map of the site.

If you have any questions concerning this letter, please contact Christopher Pyott at (978) 661-7739 or the letterhead address.

Very truly yours,

Christopher Pyott
Environmental Analyst

Stephen M. Johnson
Section Chief, Site Management
Bureau of Waste Site Cleanup

cc: Wilmington BOH
Wilmington Water Department
Data entry/file
DEP/NERO/Water Supply ATTN: Jim Persky
GEI Consultants, Incorporated, 1021 Main Street, Winchester MA 01890-1970, Attn: M. Margret Hanley
Law Environmental Consultants, Incorporated, 3 Corporate Plaza, Washington Avenue Extension, Albany, NY 12203 Attn: Michael Patenaude

TABLE 1 - AMMONIA AND SULFATE CONCENTRATIONS IN SELECT TOWN WELLS								
TOWN PARK WELL			BUTTERS ROW WELL #1			CHESTNUT STREET WELL #1		
Date	Ammonia	Sulfate	Date	Ammonia	Sulfate	Date	Ammonia	Sulfate
4/1/86	0.22	40.0						
3/24/87	0.26	40.0	3/25/88	1.38	46.0	4/1/86	0.14	29.0
3/25/88	0.18	30.0	2/13/89	3.20	100.0	3/24/87	0.33	80.0
2/13/89	0.08	27.0	5/30/90	1.49	43.0	3/25/88	0.12	33.0
5/30/90	0.30	29.0	2/21/92	2.40	67.0	2/13/89	0.19	34.0
2/21/92	0.22	31.0	9/10/92	2.10	54.0	5/30/90	0.13	20.0
9/3/92	0.34	27.0	10/20/93	3.90	85.0	2/21/92	0.10	13.0
10/20/93	0.25	27.0	2/15/94	3.70	120.0	9/3/92	0.37*	26.5*
2/15/94	0.33	31.0	5/10/94	6.30*	198.0*	10/20/93	1.60	110.0
5/10/94	0.10^	18.0	8/24/94	7.90	140.0	2/15/94	1.20	69.0
8/24/94	0.23	20.0	11/15/94	7.60	97.0	5/10/94	0.90	50.0
11/15/94	0.30	31.0	12/5/94	7.10	157.0	8/24/94	1.40	72.0
2/8/95	0.16	18.0	2/8/95	4.70	90.0	11/15/94	1.70	68.0
5/31/95	0.20	18.0	5/31/95	4.00	95.0	12/5/94	0.70	81.0
9/27/95	0.25	38.0	9/27/95	4.00	110.0	2/8/95	1.40	43.0
12/13/95	0.49	55.0	12/13/95	5.40	150.0	5/31/95	1.40	28.0
3/27/96	0.31	35.0	3/27/96	3.90	110.0	9/27/95	4.20	150.0
6/19/96	[0.1]	32.0	6/19/96	4.76	90.0	12/13/95	2.10	84.0
8/1/96	0.23	32.5	7/31/96	5.89*	109.5*	3/27/96	1.70	61.0
8/27/96	0.21	30.9	8/27/96	4.86*	100.9*	6/19/96	1.26	41.0
9/24/96	0.06	27.2	9/24/96	7.58*	154.0*	7/31/96	1.31	58.4
10/24/96	0.21	28.4	10/24/96	7.93	149.0	8/27/96	1.64	61.7
1/23/97	0.04^	15.6	12/18/96	9.37	168.0	9/24/96	1.76	104.0
2/25/97	0.04^	11.9	1/23/97	8.22	154.0	10/24/96	1.83	70.0
5/20/97	0.08	13.7	2/25/97	6.71	95.1	12/18/96	1.33	52.7
6/24/97	0.18	25.1	3/25/97	4.97	91.7	1/23/97	1.49	62.1
9/9/97	0.50^	41.0	4/23/97	3.21	73.7	2/25/97	1.71	51.0
10/21/97	0.00*	49.4*	5/20/97	3.84	76.7	4/23/97	1.41	46.2
11/11/97	0.00*	43.9*	6/24/97	3.10	63.3	5/20/97	1.48	29.6
12/3/97	0.50	57.4	9/9/97	2.48	60.0	6/24/97	2.63	52.5
1/6/98	0.54	59.2	10/21/97	2.12*	60.3*	9/9/97	7.13	194.0
2/11/98	0.58	51.9	11/11/97	2.24*	75.0*	10/21/97	7.91*	234.5*
3/10/98	0.50	42.5	12/3/97	3.34	91.9	11/11/97	7.63*	194.5*
4/14/98	0.00	44.6	1/6/98	2.56	94.9	12/3/97	5.96	131.0
			2/11/98	2.32	78.6	1/6/98	3.96	88.5
			3/9/98	1.72	74.0	2/11/98	3.44	74.1
			4/14/98	1.82	79.0	3/9/98	2.46	53.5
						4/14/98	2.08	57.9
Mean 86-92	0.23	32.0	Mean 88-92	2.11	62.0	Mean 86-92	0.20	33.6
Mean 93-98	0.24	33.3	Mean 93-98	4.76	106.2	Mean 93-98	2.56	80.6
Mean 86-98	0.24	33.0	Mean 88-98	4.39	100.0	Mean 86-98	2.11	73.2

* indicates that the result is an average of two or more samples and/or multiple analytical techniques.

^ indicates that the result is the quantitation limit.

Concentrations are in mg/l.

The quantitation limit for the data in brackets was 5.0 mg/l, which is not representative of the water quality at this well. As a result the next highest quantitation limit is used.

TABLE 2 - PUMPING RATES IN SELECT WILMINGTON TOWN WELLS (GALLONS PER MINUTE)			
DATE	TOWN PARK WELL	BUTTERS ROW WELLS 1 & 2	CHESTNUT STREET WELLS 1 & 2/1A
Jan-89	0	1102	85
Feb-89	0	828	243
Mar-89	0	849	163
Apr-89	32	831	140
May-89	123	799	123
Jun-89	132	801	147
Jul-89	62	746	186
Aug-89	138	776	167
Sep-89	182	785	220
Oct-89	96	665	206
Nov-89	99	671	199
Dec-89	51	659	185
Jan-90	0	857	256
Feb-90	0	877	219
Mar-90	11	915	233
Apr-90	136	777	122
May-90	142	924	173
Jun-90	160	1083	207
Jul-90	166	1015	221
Aug-90	150	950	222
Sep-90	117	973	236
Oct-90	90	866	220
Nov-90	83	815	191
Dec-90	62	445	171
Jan-91	0	586	177
Feb-91	0	760	196
Mar-91	0	930	199
Apr-91	96	824	154
May-91	142	789	147
Jun-91	170	958	171
Jul-91	162	990	198
Aug-91	133	780	145
Sep-91	80	574	165
Oct-91	105	788	226
Nov-91	97	752	204
Dec-91	93	741	133
Jan-92	95	738	136
Feb-92	58	738	161
Mar-92	0	525	381
Apr-92	46	485	337
May-92	94	575	364
Jun-92	114	718	254
Jul-92	71	500	530
Aug-92	98	597	362
Sep-92	51	400	371
Oct-92	0	391	405
Nov-92	7	242	278

TABLE 2 - PUMPING RATES IN SELECT WILMINGTON TOWN WELLS (GALLONS PER MINUTE)			
DATE	TOWN PARK WELL	BUTTERS ROW WELLS 1 & 2	CHESTNUT STREET WELLS 1 & 2/1A
Dec-92	0	309	379
Jan-93	0	235	524
Feb-93	0	335	753
Mar-93	4	281	566
Apr-93	0	241	539
May-93	0	293	791
Jun-93	63	569	699
Jul-93	55	608	637
Aug-93	50	554	579
Sep-93	43	442	440
Oct-93	49	198	475
Nov-93	37	276	417
Dec-93	34	254	297
Jan-94	42	326	348
Feb-94	17	242	288
Mar-94	0	258	276
Apr-94	0	312	249
May-94	0	420	449
Jun-94	59	657	624
Jul-94	95	713	644
Aug-94	70	635	514
Sep-94	40	531	423
Oct-94	0	446	532
Nov-94	2	484	440
Dec-94	0	508	374
Jan-95	0	521	458
Feb-95	0	587	372
Mar-95	0	579	373
Apr-95	0	561	378
May-95	105	682	358
Jun-95	93	669	737
Jul-95	100	757	850
Aug-95	85	753	869
Sep-95	65	663	399
Oct-95	58	515	274
Nov-95	0	558	417
Dec-95	0	532	400
Jan-96	0	646	415
Feb-96	0	266	230
Mar-96	0	468	239
Apr-96	0	386	549
May-96	3	634	118
Jun-96	5	593	314
Jul-96	3	552	510
Aug-96	3	576	458
Sep-96	2	421	377
Oct-96	2	256	383

TABLE 2 - PUMPING RATES IN SELECT WILMINGTON TOWN WELLS (GALLONS PER MINUTE)			
DATE	TOWN PARK WELL	BUTTERS ROW WELLS 1 & 2	CHESTNUT STREET WELLS 1 & 2/1A
Nov-96	0	221	456
Dec-96	0	226	463
Jan-97	0	325	461
Feb-97	0	237	518
Mar-97	0	297	310
Apr-97	0	431	359
May-97	47	303	203
Jun-97	34	272	981
Mean 89-9	78	744	221
Meam 93-	23	450	465
Mean 89-9	49	588	350

FIGURE 1 - AMMONIA CONCENTRATIONS VS. TIME IN SELECT WILIMINGTON TOWN WELLS

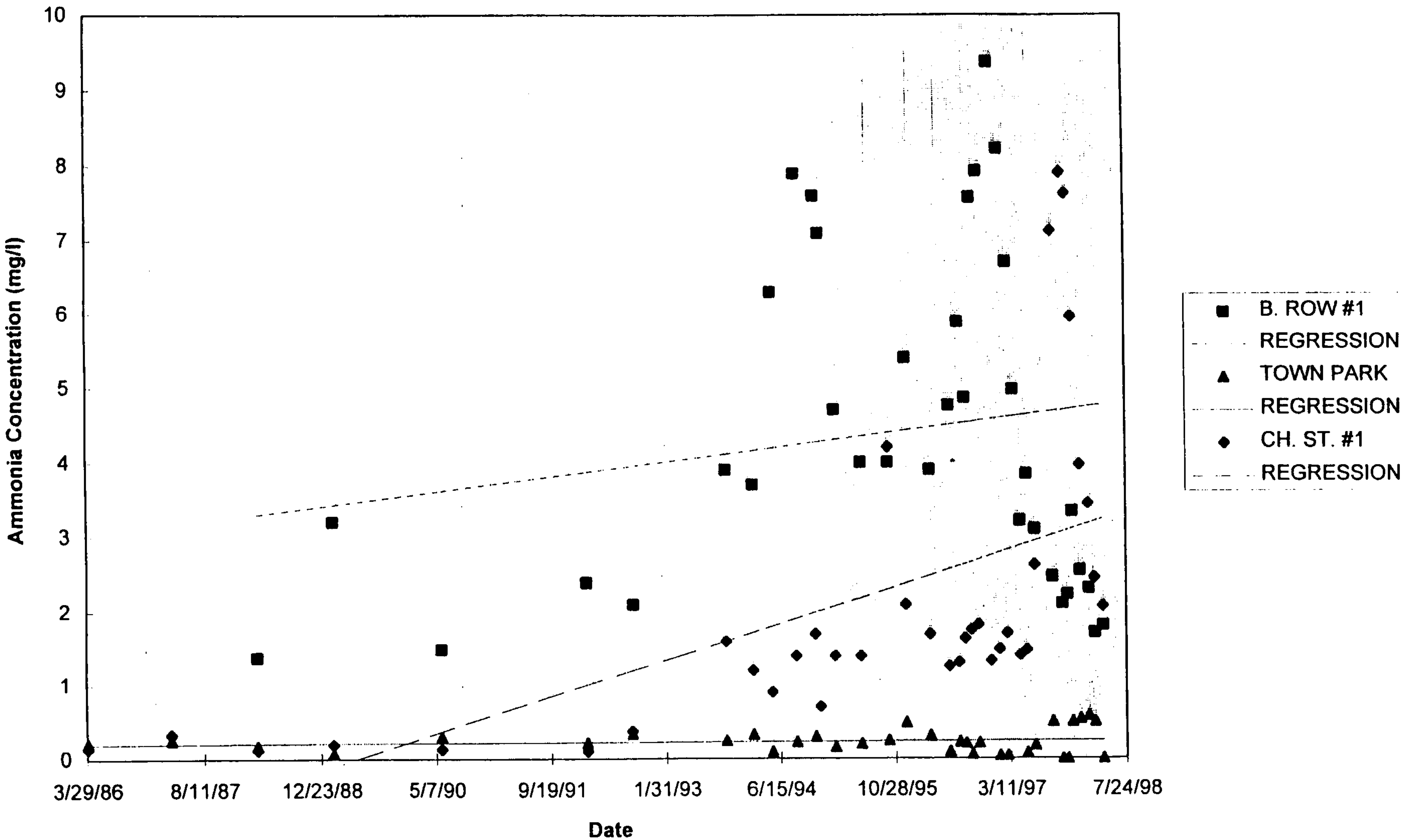


FIGURE 2 - AMMONIA CONCENTRATIONS VS. TIME IN SELECT WILIMINGTON TOWN WELLS
DATA RECORDED FOR SAMPLES COLLECTED IN THE SPRING

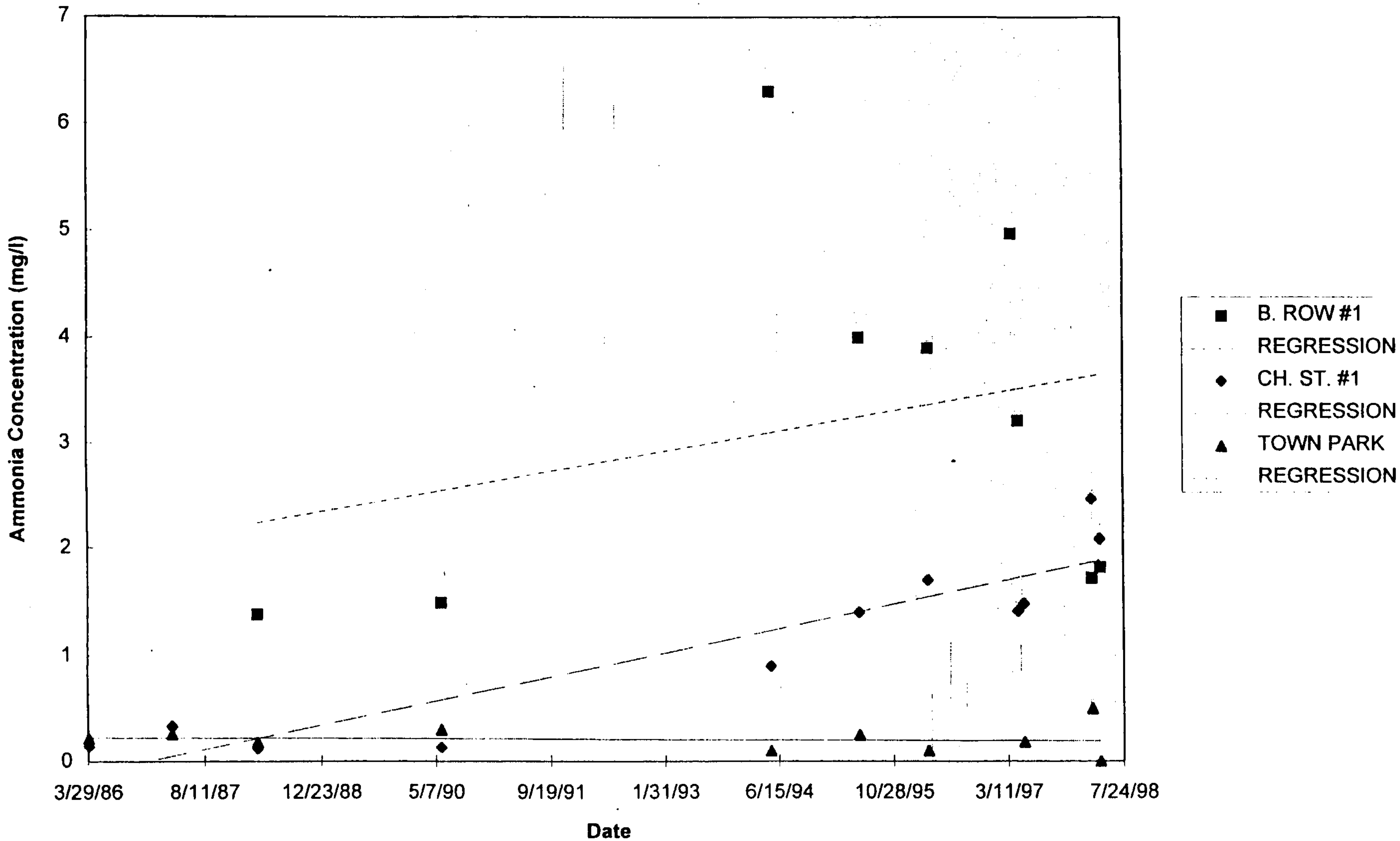


FIGURE 3 - SULFATE CONCENTRATIONS VS. TIME IN SELECT WILMINGTON TOWN WELLS

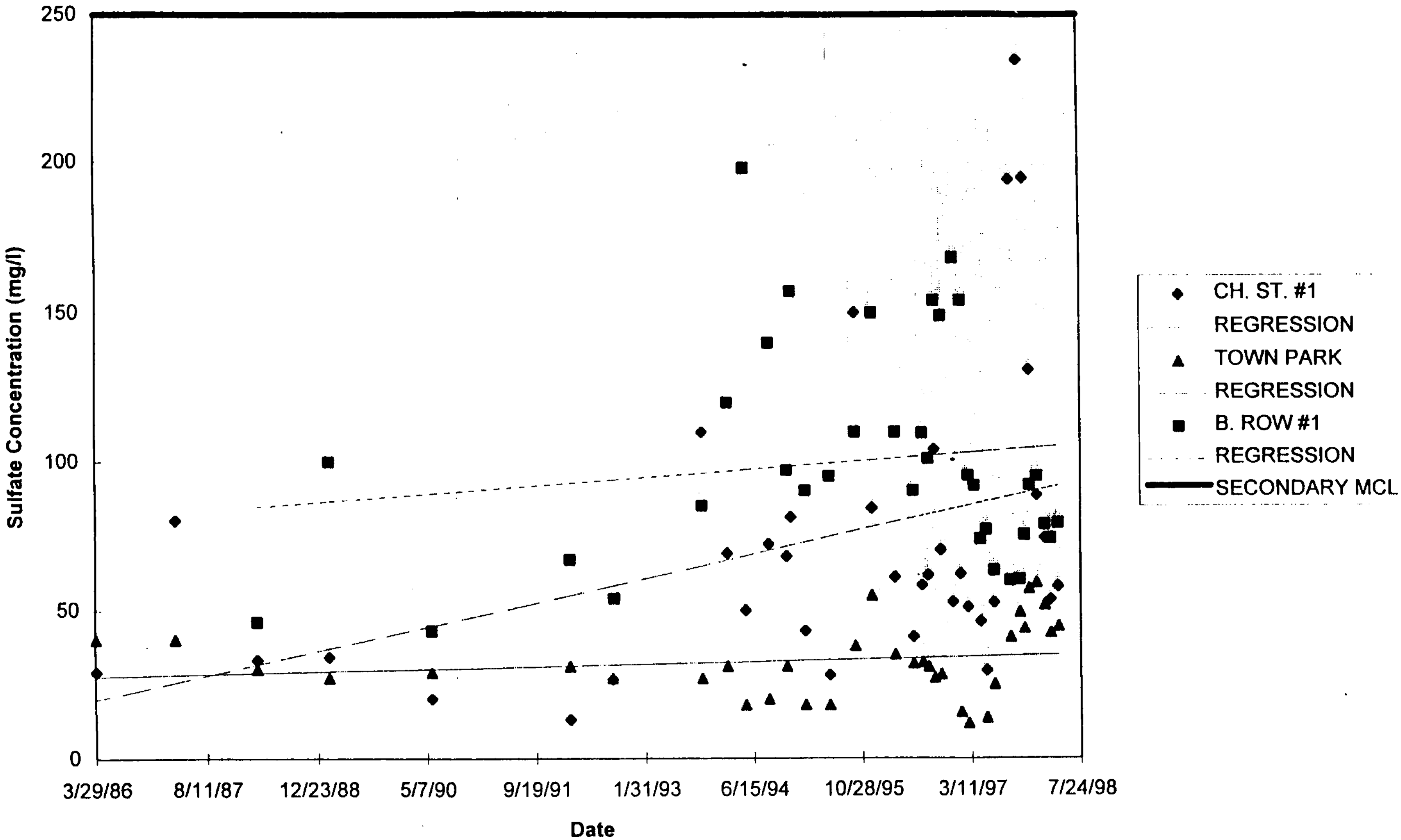


FIGURE 4 - SULFATE CONCENTRATIONS VS. TIME IN SELECT WILMINGTON TOWN WELLS
DATA RECORDED FOR SAMPLES COLLECTED IN THE SPRING

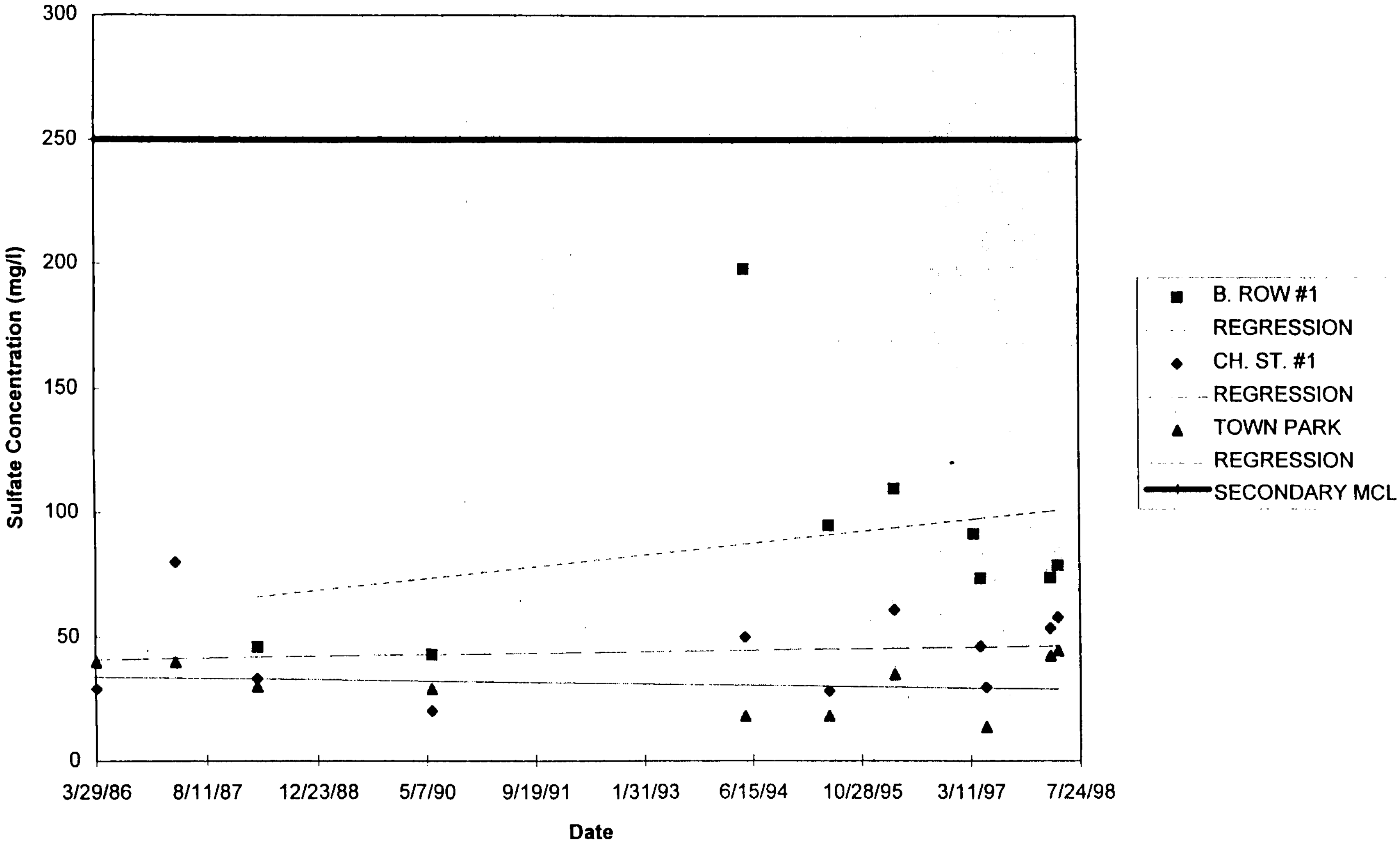


FIGURE 5 - PUMPING RATES IN SELECT WILMINGTON TOWN WELLS

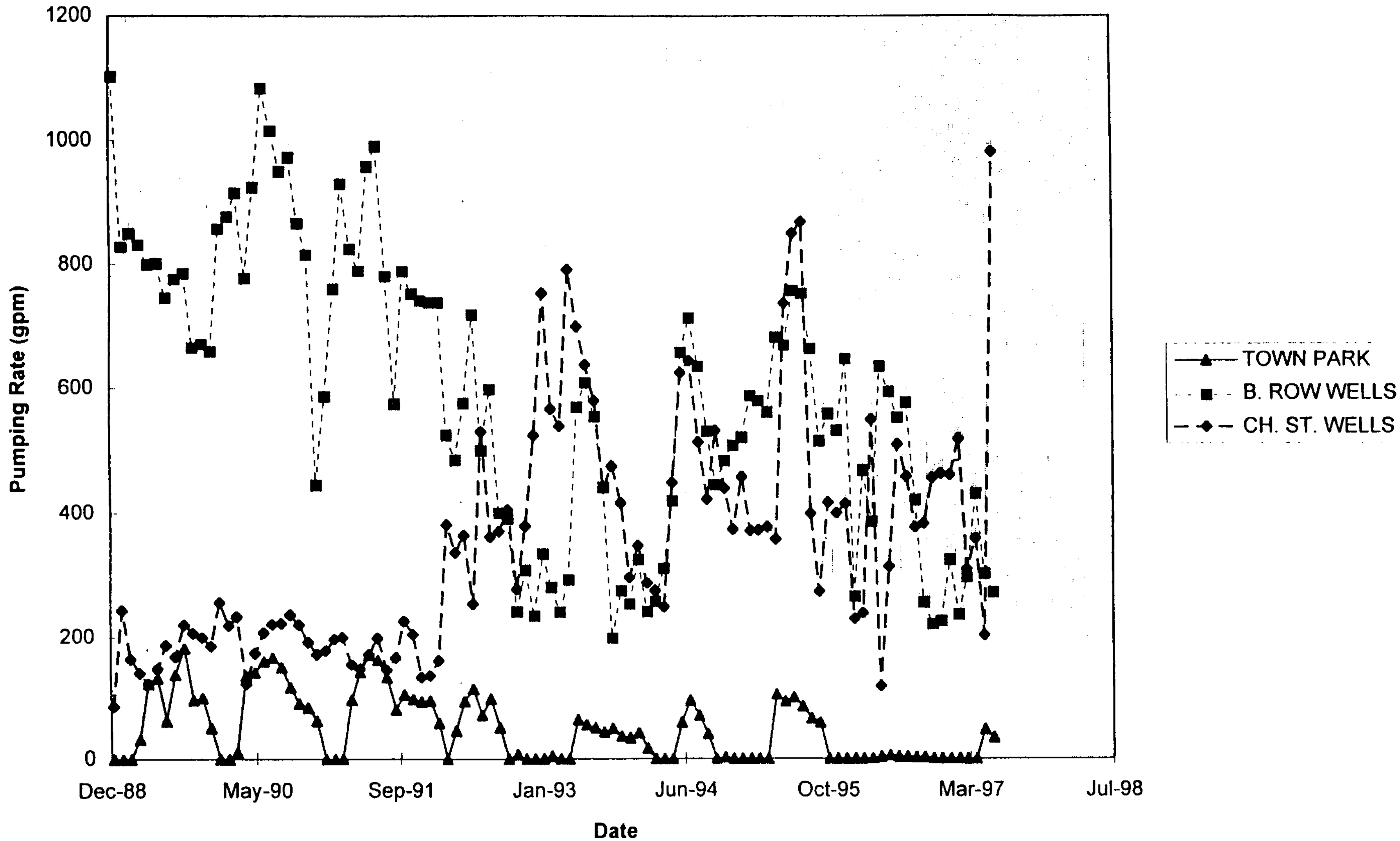


FIGURE 6 - INORGANIC CHEMISTRY ALONG WESTERN BEDROCK VALLEY (JANUARY 1997)

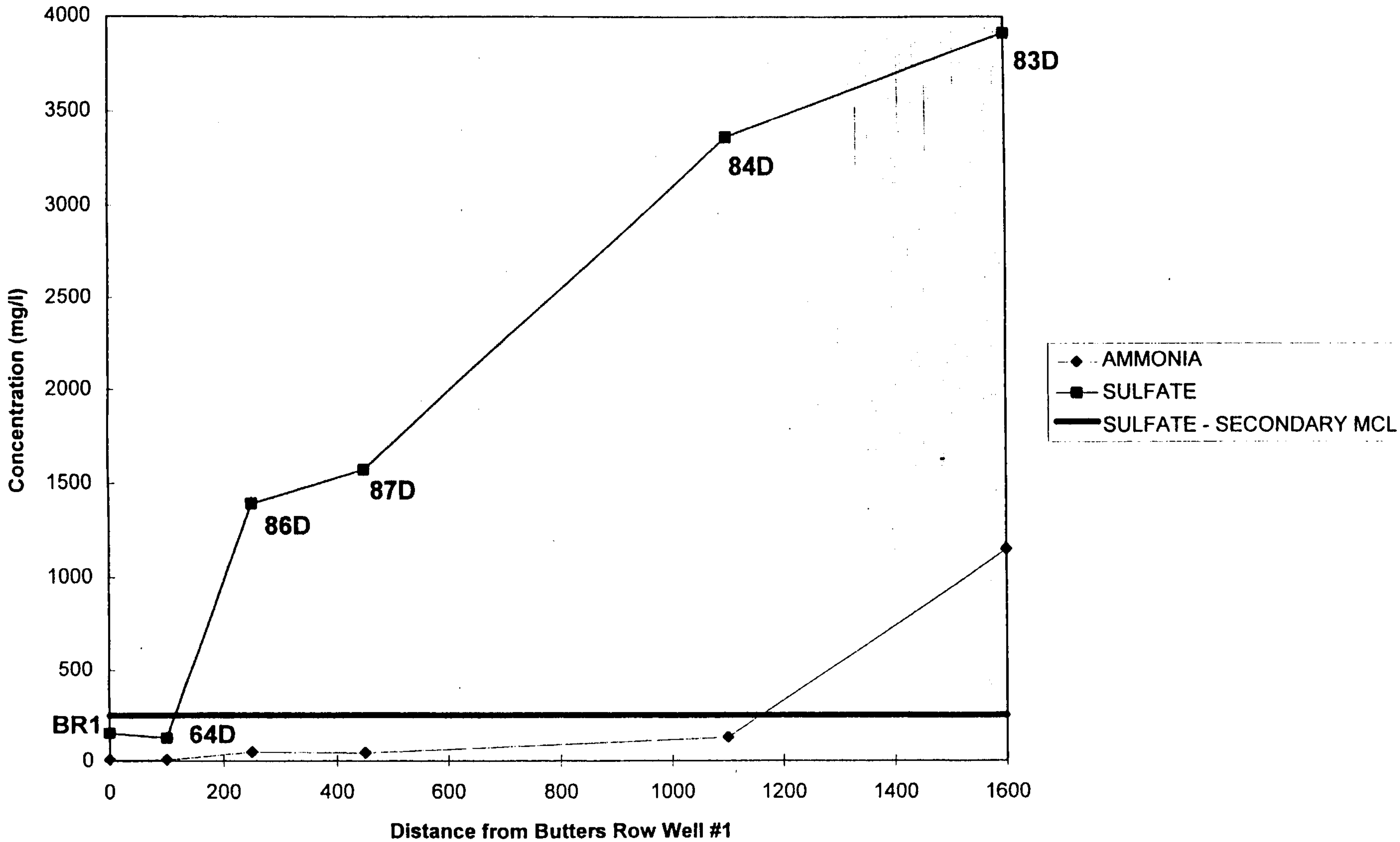
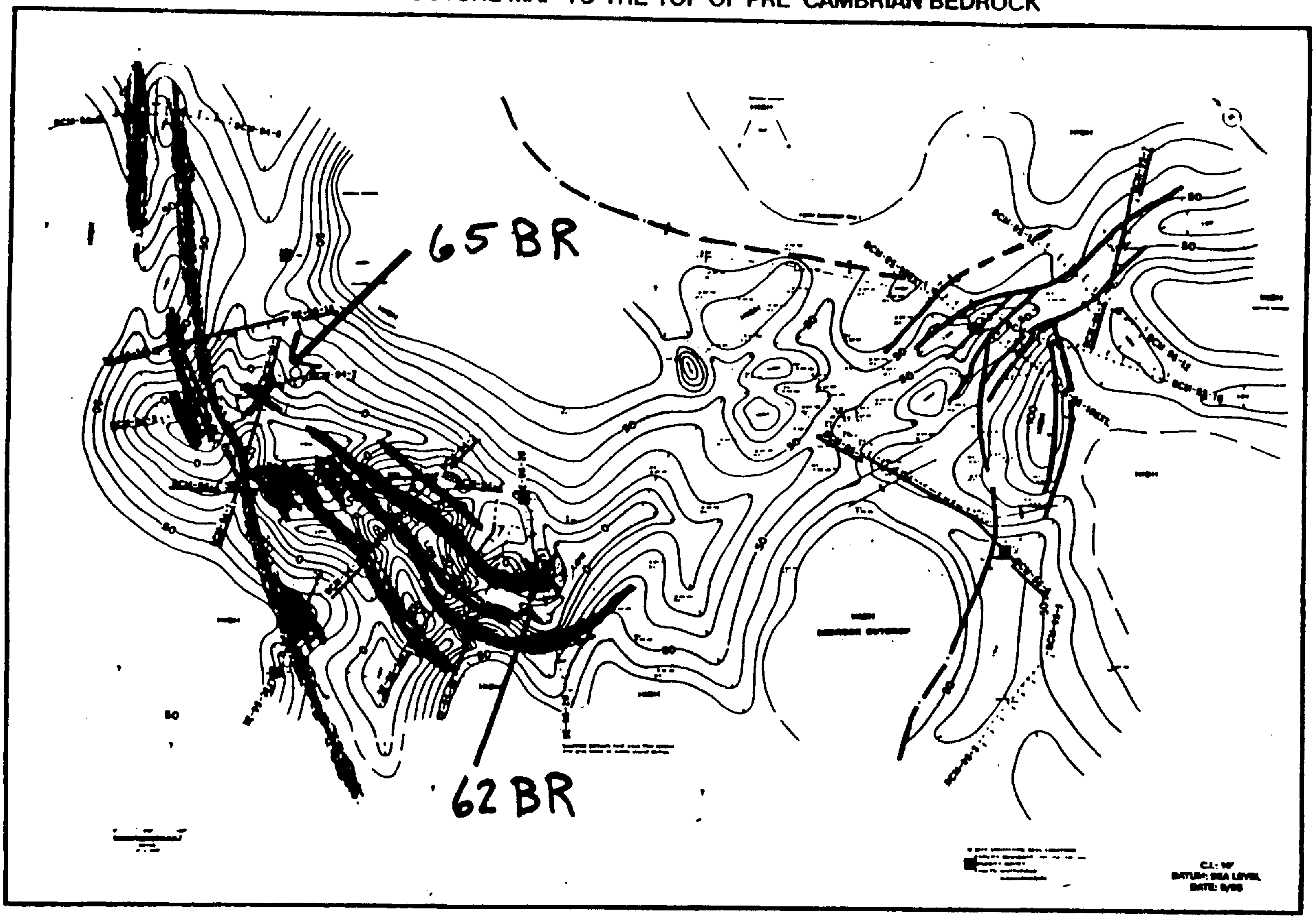


FIGURE 7

WORK IN PROGRESS MAP

SHOWING POSTULATED FAULTS 09/95

DEPTH STRUCTURE MAP TO THE TOP OF PRE-CAMBRIAN BEDROCK



Appendix B

LAWGIBB GROUP

January 8, 2001

Olin Corporation
P.O. Box 248
Lower River Road
Charleston, Tennessee 37310

Attention: **Mr. Stephen G. Morrow**

Subject: **Summary Report – Investigation Leading to the Installation of Multilevel Piezometer MP-4**
Olin Corporation
Wilmington, Massachusetts
LAW Project No. 12000-1-0018

Dear Mr. Morrow:

Law Engineering and Environmental Services, Inc. (LAW) is pleased to provide Olin Corporation with this report summarizing the field activities leading to the construction of Multilevel Piezometer MP-4. The purpose of MP-4 was to confirm the existence of a bedrock saddle just west of Main Street that effectively blocks the migration of DAPL down the Western Bedrock Valley. In a document dated April 28, 1999, the Massachusetts Department of Environmental Protection (MADEP) requested additional confirmation drilling along Main Street, specifically between SB-3 and SB-6, to ensure that MP-4 would be located in the low point of the saddle.

Determining the location and construction of the multilevel piezometer was a combined effort of LAW and Geomega. LAW was responsible for drilling the boreholes and logging the recovered samples. Three soil borings, SB-7, SB-8, and SB-9 were initially drilled to establish the low-point in the saddle. The SB-8 location was selected for the construction of MP-4.

This work was performed in general accordance with the scope of work document submitted to Olin on May 24, 1999. If you have any questions concerning the information presented herein, please contact Glenn Coffman or Paul Brafford at (770) 421-3400.

Sincerely,

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

W. Paul Brafford
W. Paul Brafford, CHMM
Senior Chemist

By SFG with permission

Glenn N. Coffman
Glenn N. Coffman, P.E.
Principal
Project Manager

INTRODUCTION

In February 1999, Olin presented a work plan to the Massachusetts Department of Environmental Protection (MADEP) to install a fourth multilevel piezometer (MP-4) in the inferred low-point of a bedrock saddle near Main Street. The purpose of the piezometer was to confirm the nature of a bedrock-high in the Main Street area and determine its effectiveness in blocking the migration of DAPL further down the Western Bedrock Valley. In an April 28, 1999 response document, MADEP requested additional confirmation drilling along Main Street, between SB-3 and SB-6, to verify that MP-4 would be located at the lowest point of the saddle.

The MP-4 piezometer was designed to address four objectives:

- Top of saddle elevation,
- Structural nature of saddle,
- Hydraulic parameters for saddle materials, i.e., till or bedrock, and
- Geochemical effects on ground-water flow through saddle materials.

LAW and Geomega combined resources to construct this multilevel piezometer. Three borings were drilled prior to selecting a location for MP-4. LAW observed the drilling of Borings SB-7, SB-8, and SB-9 by Mayer Drilling and Pump Services (Maher), logged the recovered samples, and determined specific conductance of ground water at the top-of-rock at each location. Based on this data, it was concluded that MP-4 should be constructed at the SB-8 location. The SB-8 borehole was then extended into the bedrock to the well bottom depth. This work was accomplished by Maher between April 13 and April 28, 2000. Boring logs for Borings SB-7, SB-8, and SB-9 are included in the Appendix.

LAW performed water pressure (packer) testing within isolated test segments of the SB-8 borehole to determine hydraulic conductivity of the bedrock in this area. Pressure testing of open rock segments of wells GW-62BR and GW-62D was also performed to establish comparative hydraulic conductivity values in adjacent areas. Geomega performed all subsequent investigation activities relative to the SB-8 borehole and observed the actual construction of the MP-4 piezometer. Well construction occurred between April 28 and May 15, 2000.

DRILLING PROCEDURES AND SELECTION OF PIEZOMETER MP-4 LOCATION

The following describes in more detail the field activities performed by LAW personnel relative to the drilling at potential locations for MP-4:

- Three borings, Borings SB-7, SB-8, and SB-9, were drilled intermediate of existing wells SB-3 and SB-6 to investigate the appropriate location for MP-4. A Soil Boring Location Plan is included. In each case, the borings were extended to 5 feet below the top of rock.

- Two boreholes were advanced at each designated boring location. An initial borehole was advanced by driving a perforated well point that allowed collection of ground-water samples from specific depths beneath the surface. Ground-water samples were collected with a submersible pump lowered into the drill stem and screened for specific conductance. The ground water was pumped until specific conductance measurements stabilized. A second borehole was advanced at each location using a Rotosonic (vibratory/rotary) drill rig. No water was used in this drilling process. Soil samples were obtained continuously from the surface to refusal in the bedrock.

Collected soil samples were used for identification of materials encountered and for confirmation of the depth to bedrock.

- The combination of a lower top-of-rock elevation and higher specific conductance resulted in the selection of SB-8 as the preferred location for multilevel piezometer MP-4.

FIELD SCREENING FOR SPECIFIC CONDUCTANCE

Field screening for ground-water specific conductance was performed on samples obtained during the initial drilling procedures at each location. This information was used to assist in determining the best location for multilevel piezometer MP-4. Table 1 presents field specific conductance data obtained from samples collected at the top-of-rock elevations.

PREPARING THE SB-8 LOCATION FOR CONSTRUCTION OF MP-4

After selecting the SB-8 location for construction of MP-4, the Boring SB-8 borehole was extended into the bedrock to the presumed well bottom depth of 176 feet beneath the ground surface using HQ (2-inch core) wire line equipment. The SB-7 and SB-9 boreholes were abandoned by filling with cement grout to the ground surface.

INVESTIGATIVE DERIVED WASTE

Rotosonic drilling allows the recovery of a continuous soil sample within an inner sampling tube advanced during the drilling operation. Most soils extracted during borehole drilling at these three locations were retained as samples and transported to the Olin facility (Eames Street property) for inspection. Excess soil cuttings from the drilling operations were consolidated into 4 drums of Investigative Derived Waste (IDW). IDW water was generated during the rock coring and Packer testing process in SB-8; additional water was generated during development of the MP-4 well. The equivalent of 23 drums of non-hazardous IDW water was collected. All IWD soils and water, along with all disposable equipment and potentially contaminated supplies, were placed in drums and transported to the Olin facility. Disposal of these materials was managed by on-site Olin personnel.

BOREHOLE PRESSURE TESTING

Water pressure testing was performed by Maher at various depths within the bedrock zone of Boring SB-8 to evaluate coefficients of hydraulic conductivity of the bedrock formation. Specific zones of bedrock were isolated for testing using double packer test equipment. Table 2 is the calculation spreadsheet used to develop coefficients of hydraulic conductivity for the specific bedrock zones tested. Geomega proceeded with additional down-hole testing and construction of the piezometer subsequent to packer testing.

LAW also observed water pressure testing in open bedrock sections of existing Type III wells GW-62BR and GW-BRD. Calculated coefficients of hydraulic conductivity for tested segments of bedrock at these locations are also provided in Table 2.

SURVEYING

Dana F. Perkins, Inc. provided survey services to horizontally locate the borings consistent with the state plane co-ordinate system and vertically determine the elevation of the ground surface at each boring location in feet relative to mean sea level. The survey data is provided as follows:

Boring No.	State Plane Coordinates		Ground Elevations (feet, msl)
	Northing	Easting	
SB-7	556893	691581	96.7
SB-8	556980	691608	96.5*
SB-9	557046	691629	96.3

* - SB-8 elevation is Top of MP-4 Flush Mounted Box

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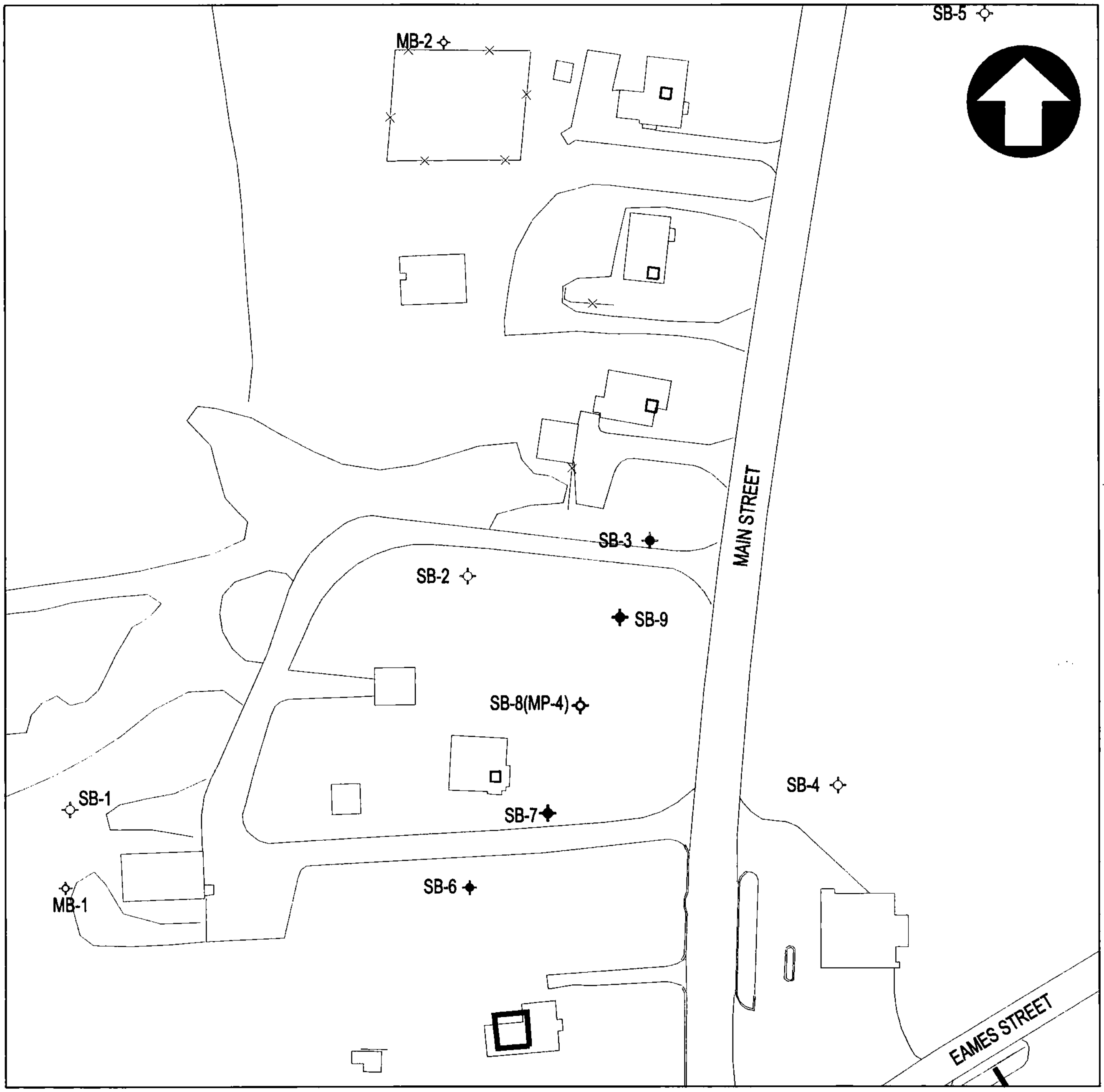


MONITORING LOCATION (PIEZOMETER)

SOIL BORING

SCALE IN FEET

0 200 400

OLIN CORPORATION WILMINGTON, MA.	LAW LAWGIBB Group Member	SOIL BORINGS SB-7, SB-8(MP-4), AND SB-9 LOCATION PLAN JOB NO. 12000-0-2014

TABLE 1
FIELD PARAMETER: SPECIFIC CONDUCTANCE

	SB-7	SB-8	SB-9
Surface Elevation (ft, msl)	96.7	96.5	96.3
Depth to Top of Rock (ft, msl)	61.0	63.0	60.0
Top of Rock Elevation (ft, msl)	35.7	33.5	36.3
Specific Conductance (uS/cm) at Top of Rock	3,715	17,870	14,560

Legend:
SB = Soil Boring
ft, msl = feet relative to mean sea level
uS/cm = micro Semiens per centimeter

TABLE 2
HYDRAULIC CONDUCTIVITY CALCULATION SPREADSHEET
DATA FROM PRESSURE TESTING WITH DOUBLE PACKER TEST EQUIPMENT
BOREHOLES SB-8; GW-62BR; and GW-62BRD

Borehole	Upper Depth (feet)	Lower Depth (feet)	Test Length (feet)	Pressure (psi)	Pressure (feet)	Flow Rate (gpm)	Flow Rate (feet3/min)	Borehole Radius (feet)	Hydraulic Conductivity (ft/min)	Hydraulic Conductivity (cm/sec)
SB-8	80	90	10	30.00	12.99		0.0510	0.166	3.5E-05	1.8E-05
SB-8	80	90	10	45.00	19.49		0.1300	0.166	6.0E-05	3.0E-05
SB-8	90	100	10	23.04	9.98	0.25	0.0334	0.166	3.0E-05	1.5E-05
SB-8	90	100	10	32.90	14.25	0.28	0.0374	0.166	2.3E-05	1.2E-05
SB-8	90	100	10	47.85	20.72	0.55	0.0735	0.166	3.2E-05	1.6E-05
SB-8	100	110	10	19.59	8.48	0.19	0.0254	0.166	2.7E-05	1.4E-05
SB-8	100	110	10	26.91	11.65	0.25	0.0334	0.166	2.6E-05	1.3E-05
SB-8	100	110	10	46.89	20.30	0.35	0.0468	0.166	2.1E-05	1.0E-05
SB-8	110	120	10	21.11	9.14	0.20	0.0267	0.166	2.6E-05	1.3E-05
SB-8	110	120	10	32.06	13.88	0.29	0.0388	0.166	2.5E-05	1.3E-05
SB-8	110	120	10	48.01	20.79	0.45	0.0602	0.166	2.6E-05	1.3E-05
SB-8	120	130	10	18.45	7.99		0.0430	0.166	4.8E-05	2.4E-05
SB-8	120	130	10	28.89	12.51		0.0580	0.166	4.1E-05	2.1E-05
SB-8	120	130	10	46.37	20.08		0.4320	0.166	1.9E-04	9.8E-05
SB-8	130	140	10	18.60	8.05	0.55	0.0735	0.166	8.2E-05	4.1E-05
SB-8	130	140	10	30.96	13.41	0.80	0.1070	0.166	7.1E-05	3.6E-05
SB-8	130	140	10	49.56	21.46	1.15	0.1537	0.166	6.4E-05	3.3E-05
SB-8	140	150	10	21.22	9.19		0.3350	0.166	3.3E-04	1.7E-04
SB-8	140	150	10	34.14	14.78		0.4830	0.166	2.9E-04	1.5E-04
SB-8	140	150	10	47.86	20.72		0.7660	0.166	3.3E-04	1.7E-04
SB-8	150	160	10	16.98	7.35	0.18	0.0241	0.166	2.9E-05	1.5E-05
SB-8	150	160	10	32.08	13.89	0.20	0.0267	0.166	1.7E-05	8.7E-06
SB-8	150	160	10	45.88	19.87	0.25	0.0334	0.166	1.5E-05	7.6E-06
SB-8	157	167	10	18.60	8.05	0.45	0.0602	0.166	6.7E-05	3.4E-05
SB-8	157	167	10	29.10	12.60	0.90	0.1203	0.166	8.5E-05	4.3E-05
SB-8	157	167	10	44.02	19.06		0.2700	0.166	1.3E-04	6.4E-05
SB-8	163	173	10	18.99	8.22	0.05	0.0067	0.166	7.3E-06	3.7E-06
SB-8	163	173	10	32.02	13.86	0.10	0.0134	0.166	8.6E-06	4.4E-06
SB-8	163	173	10	50.55	21.89	0.15	0.0201	0.166	8.2E-06	4.2E-06
GW-62BR	81	91	10	17.96	7.78	0.20	0.0267	0.166	3.1E-05	1.6E-05
GW-62BR	81	91	10	30.57	13.24	0.25	0.0334	0.166	2.3E-05	1.1E-05
GW-62BR	81	91	10	47.04	20.37	0.60	0.0802	0.166	3.5E-05	1.8E-05
GW-62BR	91	101	10	12.42	5.38	0.01	0.0007	0.166	1.1E-06	5.6E-07
GW-62BR	91	101	10	26.65	11.54	0.10	0.0134	0.166	1.0E-05	5.3E-06
GW-62BR	91	101	10	43.63	18.89	0.15	0.0201	0.166	9.5E-06	4.8E-06
GW-62BRD	108	118	10	13.60	5.89	0.05	0.0067	0.166	1.0E-05	5.2E-06
GW-62BRD	108	118	10	26.83	11.62	0.05	0.0067	0.166	5.1E-06	2.6E-06
GW-62BRD	108	118	10	46.06	19.94	0.15	0.0201	0.166	9.0E-06	4.6E-06
GW-62BRD	118	128	10	15.60	6.75	0.05	0.0067	0.166	8.8E-06	4.5E-06
GW-62BRD	118	128	10	32.37	14.01	0.10	0.0134	0.166	8.5E-06	4.3E-06
GW-62BRD	118	128	10	45.45	19.68	0.15	0.0201	0.166	9.1E-06	4.6E-06
GW-62BRD	128	138	10	23.39	10.13	0.20	0.0267	0.166	2.4E-05	1.2E-05
GW-62BRD	128	138	10	33.24	14.39	0.30	0.0401	0.166	2.5E-05	1.3E-05
GW-62BRD	128	138	10	46.61	20.18	0.55	0.0735	0.166	3.3E-05	1.7E-05

APPENDIX

BORING RECORDS FOR BORING SB-7, SB-8, AND SB-9

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	ELEV (ft)
0	Topsoil	0.0
2	Dark yellowish brown SAND and GRAVEL	
24	Coarse GRAVEL	
61	Top of BEDROCK	
65	Boring terminated at 65 feet	-65.0

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

SAMPLES: IDENT | TYPE | N-COUNT (1st 1.75" / 2nd 1.75" / 3rd 1.75")

PL (%) — NM (%) — LL (%); ▲ FINES (%); ● SPT (bpf)

DRILLER: Boart Longyear
EQUIPMENT: Truck Mounted Drill Rig
METHOD: Rotasonic
HOLE DIA.: 6-inch
REMARKS: Boring abandoned 4/17/00 using Portland Cement Grout.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: OLIN/WILMINGTON

DRILLED: April 13-14, 2000 **BORING NO.:** SB-7

PROJ. NO.: 12000-0-2014 **PAGE** 1 **OF** 1

LAW
LAWGIBB Group Member

DEPTH (ft)	DESCRIPTION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES: FRACT	FRACT ORIENT	RQD / % REC	REMARKS	WELL DIAGRAM
0	TOPSOIL						Multi-level piezometer installed utilizing 2-inch diameter PVC riser and 2-inch diameter stainless steel sample ports. Sample ports are 6-inches in length.	
2	Yellow-brown SAND and GRAVEL						2-inch PVC riser grouted in place from 0.0' to 20.0' BGS.	5
10							Bentonite, sand and sample port intervals are illustrated on the well diagram to the right.	10
15								15
20								20
25	Coarse GRAVEL						PORT 14	25
30								30
35								35
40							PORT 13	

ROCK 7-0063RC.GPJ LAW_GIBB.GDT 6/28/01

DRILLER:	Boart Longyear / D.L. Maher
EQUIPMENT:	Truck Mounted Rig
METHOD:	Rotasonic / HQ Wire-line coring
HOLE DIA.:	SEE BELOW
REMARKS:	0.0' to 75.0' drilled with rotasonic rig, advancing a 6-inch diameter casing. 75.0' to 176.0' drilled using HQ wire-line coring rig. HQ borehole reamed to 6-inch diameter using mud-rotary rig.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

TEST BORING RECORD

PROJECT: OLIN/WILMINGTON

DRILLED: April 15 - May 15, 2000 **BORING NO.:** SB-8
WELL NO.: MP-4

PROJ. NO.: 12000-0-2014/09/02

LAW
LAWGIBB Group Member

DEPTH (ft)	DESCRIPTION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES: FRACT	FRACT ORIENT	RQD / % REC	REMARKS	WELL DIAGRAM
40	SAND and GRAVEL							
45								45
50							PORT 12	50
55							PORT 11	55
60							PORT 10	60
	Dark green-gray clayey SILT with rock fragments - Till						PORT 9	
65	Green-brown, severely weathered BEDROCK							65
70								70
75	Greenish brown severely weathered amphibolite GNEISS						PORT 8	75
80								

ROCK 7-0063RC.GPJ LAW_GIBB.GDT 6/28/01

DRILLER: Boart Longyear / D.L. Maher
EQUIPMENT: Truck Mounted Rig
METHOD: Rotasonic / HQ Wire-line coring
HOLE DIA.: SEE BELOW
REMARKS: 0.0' to 75.0' drilled with rotasonic rig, advancing a 6-inch diameter casing. 75.0' to 176.0' drilled using HQ wire-line coring rig. HQ borehole reamed to 6-inch diameter using mud-rotary rig.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

TEST BORING RECORD

PROJECT: OLIN/WILMINGTON

DRILLED: April 15 - May 15, 2000 **BORING NO.:** SB-8
WELL NO.: MP-4

PROJ. NO.: 12000-0-2014/09/02

LAW
LAWGIBB Group Member

DEPTH (ft)	DESCRIPTION (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	LEGEND	ELEV (ft)	SAMPLES: FRACT	SAMPLES: FRACT ORIENT	SAMPLES: RQD / % REC	REMARKS	WELL DIAGRAM
80	Greenish brown severely weathered amphibolite GNEISS							
85							PORT 7	85
	Green-brown, moderately weathered amphibolite GNEISS.					56 / 68		
					30°			
					45°		Severely weathered fracture at 88.6' Calcite crystals on fractures at 89.0 to 90.0'	
90								90
						59 / 100		
					90°		Tight fracture at 93.3'	
	Dark gray medium grained hornblende-fsp GNEISS with few fsp clasts and thin pegmatitic veins, slightly weathered.							
95	Dark green-gray SCHIST							95
	Dark gray medium grained hornblende-fsp GNEISS with few fsp clasts and thin pegmatitic veins, slightly weathered.				55°		Tight calcite-filled fracture at 95.3'	
						76 / 100	PORT 6	
					90°			
100					60°		Broken, moderately weathered at 99.8' and 100.7'.	100
	Dark gray, slightly weathered AMPHIBOLITE				48°-60°			
							Numerous intact filled fractures from 101.0' to 108.0'	
105								105
						77 / 93		
110							Broken, moderately weathered at 108.0' and 110.6' PORT 5	110
	Black fine grained, moderately weathered, DIABASE.						Broken fragments	
	Dark gray, slightly to moderately weathered AMPHIBOLITE.					21 / 98		
					45°			
	Black DIABASE contact 60°				45°	21 / 100		
115					80°-90°		Calcite filled fractures from 114.3' to 116.0'	115
	Dark gray AMPHIBOLITE-banded with irregular fsp veins, foliation 45°				45°			
					45°	52 / 100		
					60°			
					50°		Broken, clayey zone at 119.5'	
120								

ROCK 7-0063RC.GPJ LAW_GIBB.GDT 6/28/01

DRILLER: Boart Longyear / D.L. Maher
EQUIPMENT: Truck Mounted Rig
METHOD: Rotasonic / HQ Wire-line coring
HOLE DIA.: SEE BELOW
REMARKS: 0.0' to 75.0' drilled with rotasonic rig, advancing a 6-inch diameter casing. 75.0' to 176.0' drilled using HQ wire-line coring rig. HQ borehole reamed to 6-inch diameter using mud-rotary rig.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

TEST BORING RECORD

PROJECT: OLIN/WILMINGTON

DRILLED: April 15 - May 15, 2000 **BORING NO.:** SB-8
WELL NO.: MP-4

PROJ. NO.: 12000-0-2014/09/02

LAW
LAWGIBB Group Member

DEPTH (ft)	DESCRIPTION
120	Dark gray AMPHIBOLITE-banded with irregular fsp veins, foliation 45°
	Light gray fine to medium grained QUARTZITE, slightly vuggy
125	Dark gray fine medium grained hornblende-fsp amphibolite GNEISS, foliation 70°
	Medium gray, medium to coarse grained, biotite - hornblende - feldspar GNEISS, foliation of 60°
	Dark gray to black AMPHIBOLITE, foliation of 60°
	Dark gray banded AMPHIBOLITE, strong foliation of 45°
	Dark gray, banded GNEISS with coarse pink feldspar clasts, foliation of 75°
	Medium gray, medium grained, hornblende - feldspar GNEISS
	Medium gray, banded GNEISS
	Light gray QUARTZITE
	Medium gray, banded GNEISS
160	Dark gray med. grained, weakly fol. hornblende-fsp GNEISS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

SAMPLES: FRACT ORIENT	RQD / % REC	REMARKS
40°, 80°	14 / 100	
70°, 70°, 70°	52 / 100	Moderately weathered fractures at 124.0'
		PORT 4
55°, 45°	90 / 100	Tight fracture at 129.3'
70°, 10°, 45°, 60°, 90°	90 / 96	Fractures from 135.4' to 137.4' filled with calcite; Chlorite / calcite filled fracture at 140.0'
70°, 45°, 45°	65 / 100	PORT 3
60°, 45°, 40°-50°	77 / 100	Chlorite / calcite filled fracture at 145.6'; Very coarse calcite crystals in fracture at 148.0'
75°, 45°, 90°, 80°	35 / 100	
45°, 60°, 60°, 10°	22 / 100	PORT 2; Calcite filled fractures at 157.2'

ROCK 7-0063RC.GPJ LAW_GIBB.GDT 6/28/01

DRILLER: Boart Longyear / D.L. Maher
EQUIPMENT: Truck Mounted Rig
METHOD: Rotasonic / HQ Wire-line coring
HOLE DIA.: SEE BELOW
REMARKS: 0.0' to 75.0' drilled with rotasonic rig, advancing a 6-inch diameter casing. 75.0' to 176.0' drilled using HQ wire-line coring rig. HQ borehole reamed to 6-inch diameter using mud-rotary rig.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

TEST BORING RECORD

PROJECT: OLIN/WILMINGTON
DRILLED: April 15 - May 15, 2000 **BORING NO.:** SB-8
WELL NO.: MP-4
PROJ. NO.: 12000-0-2014/09/02

LAW
LAWGIBB Group Member

DEPTH (ft)	DESCRIPTION (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	FRACT ORIENT	RQD / % REC	REMARKS
160	Dark gray, medium grained, AMPHIBOLITE with pegmatitic veins, foliation 45°		36 / 100	
164		80°-90°		Fracture with greenish fill at 164.0'
165				
166	Dark gray, poorly foliated, AMPHIBOLITE with very coarse fsp. and hornblende clasts	90°		PORT 1
167				Vuggy from 167.0' to 168.5', quartz and other minerals
168		60°		Intact - partially open fracture at 168.2'
169	Gray mylanitic GNEISS			
170	Dark gray medium to coarse grained AMPHIBOLITE with pegmatitic veins. Foliation 55°	55°		
171		15° 80° 30°-70°	84 / 100	Iron-stained fractures between 170.5' and 171.5'
173				Drilling cuttings from 173.0' to 176.0' BGS.
175	PEGMATITE, 20° foliation			
	Green-gray, fine to coarse grained AMPHIBOLITE. 45° foliation.			
176	Boring terminated at 176 feet			

180 185 190 195 200

ROCK 7-0063RC.GPJ LAW_GIBB.GDT 6/28/01

DRILLER: Boart Longyear / D.L. Maher
EQUIPMENT: Truck Mounted Rig
METHOD: Rotasonic / HQ Wire-line coring
HOLE DIA.: SEE BELOW
REMARKS: 0.0' to 75.0' drilled with rotasonic rig, advancing a 6-inch diameter casing. 75.0' to 176.0' drilled using HQ wire-line coring rig. HQ borehole reamed to 6-inch diameter using mud-rotary rig.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

TEST BORING RECORD

PROJECT: OLIN/WILMINGTON

DRILLED: April 15 - May 15, 2000 **BORING NO.:** SB-8
WELL NO.: MP-4

PROJ. NO.: 12000-0-2014/09/02

LAW
LAWGIBB Group Member

Depth (ft)	Soil Classification and Remarks	Elev (ft)
0	Topsoil	0.0
1	SAND and GRAVEL	
20	Coarse GRAVEL	-20.0
45	SAND and GRAVEL	-45.0
59	SAND with coarse gravel	
60	GRAVEL with silt and clay	-60.0
61	TILL - Dark greenish gray clayey SILT	
64	Severely weathered BEDROCK	
65	Boring terminated at 65 feet	-65.0

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

SAMPLES: IDENT, TYPE, N-COUNT (1st 1.75", 2nd 1.75", 3rd 1.75")

PL (%) — NM (%) — LL (%); ▲ FINES (%); ● SPT (bpf)

DRILLER: Boart Longyear
EQUIPMENT: Truck Mounted Drill Rig
METHOD: Rotasonic
HOLE DIA.: 6-inch
REMARKS: Boring abandoned 4/17/00 using Portland Cement Grout.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: OLIN/WILMINGTON

DRILLED: April 16, 2000 **BORING NO.:** SB-9

PROJ. NO.: 12000-0-2014 **PAGE 1 OF 1**

LAW
LAWGIBB Group Member

SOIL1 0-2014.GPJ LAW_GIBB.GDT 6/28/01

Appendix C

SB-8/MP-4

Orientation Summary Table
BIPS Features
Olin, Wilmington, Well: SB-8MP-4
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
1	22.99	75.4	271	73	0
2	23.18	76.0	297	49	0
3	23.21	76.2	304	50	0
4	23.34	76.6	233	87	2
5	23.63	77.5	278	42	1
6	23.71	77.8	289	51	1
7	23.80	78.1	291	46	0
8	23.91	78.4	274	46	0
9	23.99	78.7	287	51	1
10	24.03	78.8	291	59	0
11	24.07	79.0	302	57	1
12	24.10	79.1	306	54	1
13	24.23	79.5	283	48	0
14	24.29	79.7	306	66	0
15	24.30	79.7	294	47	0
16	24.40	80.0	287	63	0
17	24.40	80.1	24	35	0
18	24.48	80.3	284	55	0
19	24.52	80.4	290	54	0
20	24.58	80.6	292	54	0
21	24.64	80.8	296	59	0
22	24.70	81.0	294	57	0
23	24.74	81.2	289	60	0
24	24.80	81.4	295	62	0
25	24.88	81.6	319	66	0
26	24.90	81.7	265	31	0
27	24.95	81.9	268	28	0
28	24.99	82.0	271	23	1
29	25.02	82.1	275	21	1
30	25.08	82.3	22	39	1
31	25.11	82.4	25	36	0
32	25.20	82.7	111	16	0
33	25.21	82.7	302	33	0
34	25.28	82.9	313	34	1
35	25.33	83.1	314	32	1
36	25.40	83.3	318	43	0
37	25.46	83.5	325	51	0
38	25.54	83.8	324	60	0
39	25.58	83.9	329	61	1
40	25.65	84.1	334	65	0
41	25.68	84.2	335	66	1
42	25.72	84.4	330	61	1
43	25.75	84.5	328	48	2
44	25.78	84.6	327	42	1

All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin, Wilmington, Well: SB-8MP-4
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
45	25.80	84.6	325	42	0
46	25.82	84.7	325	43	0
47	25.84	84.8	324	40	1
48	25.88	84.9	328	42	1
49	25.94	85.1	326	42	1
50	25.95	85.1	194	60	1
51	26.01	85.3	342	35	1
52	26.09	85.6	6	58	1
53	26.14	85.8	353	44	0
54	26.20	85.9	317	5	0
55	26.29	86.2	330	59	0
56	26.40	86.6	325	60	0
57	26.49	86.9	319	59	0
58	26.71	87.6	323	54	0
59	26.84	88.1	306	45	0
60	26.87	88.2	313	54	0
61	26.90	88.3	309	53	0
62	26.93	88.3	311	52	0
63	26.96	88.4	310	50	0
64	27.01	88.6	312	51	1
65	27.05	88.8	314	51	0
66	27.10	88.9	102	39	1
67	27.12	89.0	100	42	1
68	27.12	89.0	306	54	0
69	27.15	89.1	322	50	1
70	27.16	89.1	304	53	0
71	27.25	89.4	297	55	0
72	27.30	89.6	303	51	1
73	27.43	90.0	273	21	1
74	27.54	90.4	286	55	0
75	27.64	90.7	280	66	1
76	27.70	90.9	336	43	1
77	27.72	90.9	335	48	1
78	27.75	91.1	149	44	1
79	27.85	91.4	357	40	0
80	27.86	91.4	160	36	1
81	27.90	91.5	4	42	0
82	27.92	91.6	2	46	0
83	28.01	91.9	333	49	0
84	28.03	92.0	338	48	1
85	28.10	92.2	327	49	0
86	28.18	92.4	348	55	0
87	28.24	92.7	324	49	1
88	28.27	92.7	334	49	0

All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin, Wilmington, Well: SB-8MP-4
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
89	28.32	92.9	333	48	0
90	28.40	93.2	336	52	0
91	28.43	93.3	336	51	0
92	28.51	93.5	340	44	0
93	28.59	93.8	341	66	1
94	28.63	93.9	327	47	0
95	28.72	94.2	332	53	0
96	28.76	94.4	320	49	0
97	28.79	94.5	317	53	0
98	28.84	94.6	331	54	0
99	28.89	94.8	330	60	0
100	28.92	94.9	154	59	0
101	28.94	94.9	312	57	0
102	29.00	95.1	249	15	0
103	29.01	95.2	320	57	0
104	29.13	95.6	310	51	0
105	29.17	95.7	305	54	1
106	29.30	96.1	314	51	0
107	29.30	96.1	333	65	0
108	29.38	96.4	229	68	0
109	29.61	97.1	311	46	0
110	29.64	97.2	324	52	0
111	29.70	97.4	357	4	1
112	29.76	97.6	356	10	1
113	29.78	97.7	354	9	1
114	29.82	97.8	338	60	1
115	29.82	97.8	329	6	0
116	29.91	98.1	325	48	0
117	30.00	98.4	326	56	0
118	30.12	98.8	317	47	0
119	30.23	99.2	295	55	0
120	30.31	99.4	308	55	0
121	30.33	99.5	117	6	0
122	30.35	99.6	34	5	0
123	30.55	100.2	248	67	0
124	30.66	100.6	258	74	1
125	31.02	101.8	291	26	0
126	31.38	102.9	240	87	2
127	31.85	104.5	134	82	1
128	32.13	105.4	141	48	2
129	32.22	105.7	280	47	0
130	32.48	106.6	239	49	0
131	32.56	106.8	260	47	0
132	32.66	107.2	286	65	0

All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin, Wilmington, Well: SB-8MP-4
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
133	32.77	107.5	341	72	0
134	32.81	107.6	121	54	1
135	32.88	107.9	290	48	0
136	32.92	108.0	288	49	0
137	32.94	108.1	292	49	0
138	33.07	108.5	293	58	0
139	33.15	108.8	290	67	0
140	33.22	109.0	274	12	0
141	33.44	109.7	232	27	0
142	33.51	110.0	228	29	0
143	33.65	110.4	133	8	0
144	33.69	110.5	151	13	0
145	33.76	110.8	347	32	0
146	33.77	110.8	255	72	1
147	33.85	111.0	345	55	1
148	33.85	111.1	275	69	0
149	33.91	111.3	314	41	0
150	33.96	111.4	286	42	0
151	34.04	111.7	271	45	0
152	34.19	112.2	159	50	0
153	34.29	112.5	157	50	0
154	34.30	112.5	347	56	0
155	34.36	112.7	157	50	0
156	34.58	113.5	155	68	1
157	34.66	113.7	164	71	1
158	34.71	113.9	14	51	1
159	34.72	113.9	11	60	1
160	34.75	114.0	12	46	1
161	35.01	114.9	127	70	0
162	35.13	115.2	129	44	2
163	35.16	115.4	118	71	0
164	35.20	115.5	307	68	0
165	35.29	115.8	113	51	1
166	35.44	116.3	295	54	0
167	35.47	116.4	298	53	0
168	35.62	116.9	298	63	0
169	35.64	116.9	100	73	0
170	35.78	117.4	106	71	0
171	35.81	117.5	169	31	0
172	35.83	117.5	301	30	0
173	35.87	117.7	293	30	0
174	35.87	117.7	149	41	0
175	35.89	117.7	349	29	0
176	35.91	117.8	285	32	0

All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin, Wilmington, Well: SB-8MP-4
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
177	36.01	118.1	318	65	0
178	36.03	118.2	312	60	0
179	36.11	118.5	313	48	0
180	36.20	118.8	320	37	0
181	36.26	119.0	299	46	0
182	36.29	119.1	107	65	0
183	36.43	119.5	326	54	0
184	36.53	119.9	170	38	0
185	36.61	120.1	296	48	0
186	36.68	120.3	311	38	0
187	36.74	120.5	320	45	0
188	36.86	120.9	312	62	0
189	36.94	121.2	315	64	0
190	37.00	121.4	329	68	0
191	37.26	122.2	328	74	0
192	37.30	122.4	329	71	1
193	37.35	122.6	322	62	0
194	37.41	122.7	121	39	1
195	37.50	123.0	175	44	0
196	37.56	123.2	310	1	1
197	37.65	123.5	7	57	0
198	37.73	123.8	341	36	1
199	37.80	124.0	334	58	1
200	38.09	125.0	348	70	1
201	38.28	125.6	319	69	0
202	38.41	126.0	278	60	0
203	38.43	126.1	265	58	0
204	38.49	126.3	267	57	0
205	38.97	127.9	297	61	0
206	39.07	128.2	272	52	0
207	39.14	128.4	122	67	0
208	39.28	128.9	95	7	1
209	39.29	128.9	130	65	0
210	39.33	129.0	276	59	0
211	39.34	129.1	126	66	0
212	39.41	129.3	279	65	0
213	39.51	129.6	27	73	0
214	39.58	129.9	224	19	0
215	39.63	130.0	280	66	0
216	39.75	130.4	278	64	0
217	39.84	130.7	272	59	0
218	40.01	131.3	276	72	0
219	40.19	131.9	355	65	0
220	40.42	132.6	281	56	0

All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin, Wilmington, Well: SB-8MP-4
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
221	40.52	132.9	281	65	0
222	40.61	133.2	276	58	0
223	40.68	133.5	289	63	0
224	40.74	133.7	280	59	0
225	40.84	134.0	292	48	0
226	40.96	134.4	291	37	0
227	41.03	134.6	337	73	0
228	41.05	134.7	292	40	0
229	41.13	134.9	284	51	0
230	41.20	135.2	287	57	0
231	41.29	135.4	294	63	0
232	41.61	136.5	277	49	0
233	41.70	136.8	287	55	0
234	41.75	137.0	290	53	0
235	41.83	137.2	292	60	0
236	41.98	137.7	284	58	0
237	42.07	138.0	277	45	0
238	42.20	138.4	270	58	0
239	42.37	139.0	307	49	0
240	42.46	139.3	120	53	0
241	42.49	139.4	296	55	0
242	42.76	140.3	312	72	0
243	42.82	140.5	248	47	0
244	42.82	140.5	185	25	1
245	43.00	141.1	259	45	0
246	43.07	141.3	259	46	0
247	43.23	141.8	274	48	0
248	43.31	142.1	274	53	0
249	43.40	142.4	262	47	0
250	43.71	143.4	288	42	0
251	43.82	143.8	303	43	1
252	43.90	144.0	278	44	0
253	43.96	144.2	275	45	0
254	44.17	144.9	251	39	0
255	44.21	145.0	256	39	0
256	44.26	145.2	263	37	0
257	44.29	145.3	243	42	0
258	44.37	145.6	269	54	0
259	44.45	145.8	266	53	0
260	44.54	146.1	311	19	0
261	44.60	146.3	127	50	1
262	44.60	146.3	303	21	0
263	44.71	146.7	109	27	0
264	44.71	146.7	276	46	0

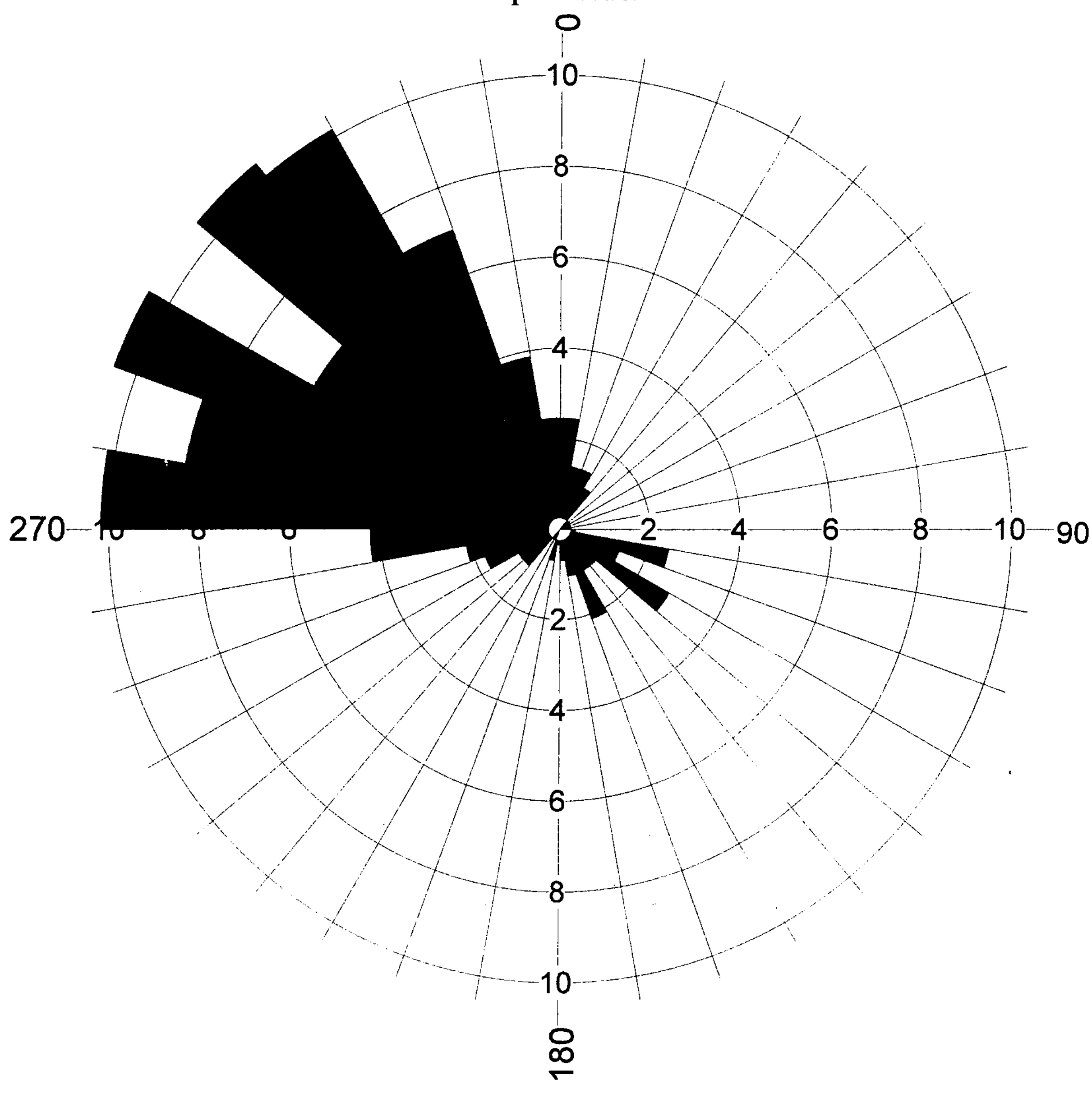
All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin, Wilmington, Well: SB-8MP-4
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
265	44.99	147.6	277	63	0
266	45.07	147.9	278	58	0
267	45.15	148.1	273	54	0
268	45.25	148.5	269	43	0
269	45.27	148.5	355	61	0
270	45.30	148.6	10	69	0
271	45.47	149.2	102	8	0
272	45.51	149.3	261	50	0
273	45.57	149.5	261	54	0
274	45.79	150.2	289	37	0
275	45.94	150.7	276	58	0
276	46.08	151.2	32	65	0
277	46.19	151.5	31	74	0
278	46.39	152.2	198	5	0
279	46.49	152.5	314	46	0
280	46.73	153.3	319	62	0
281	46.89	153.8	333	58	0
282	47.14	154.6	308	48	0

All directions are with respect to magnetic north.

Rose Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: SB-8/MP-4
April 26, 2000

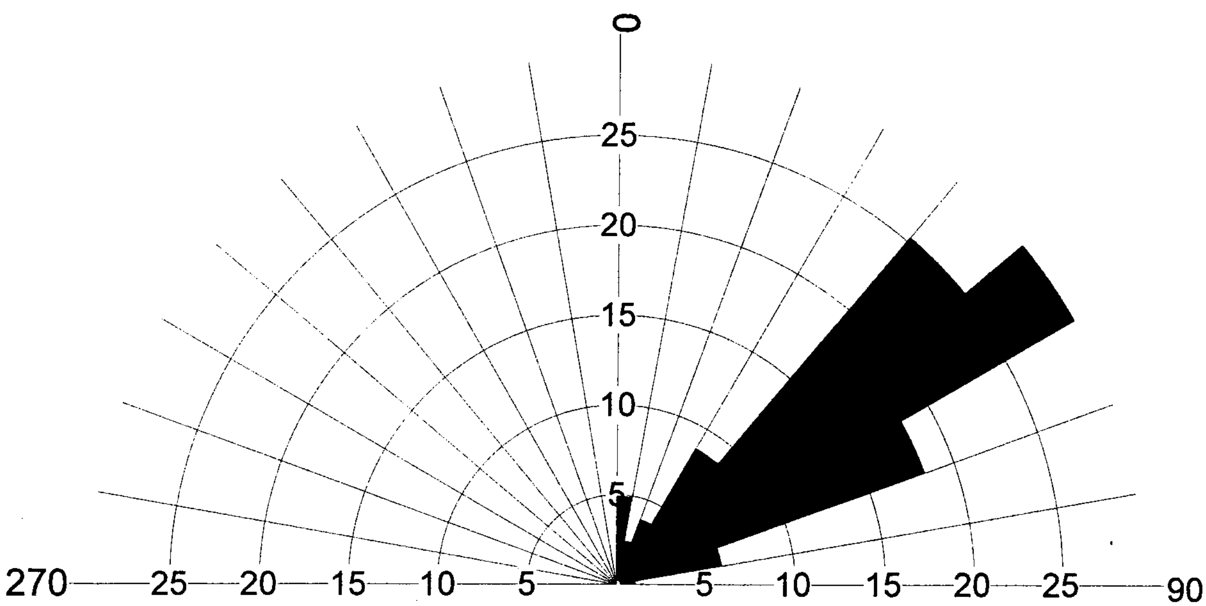


All directions are with respect to magnetic north.

COLOG

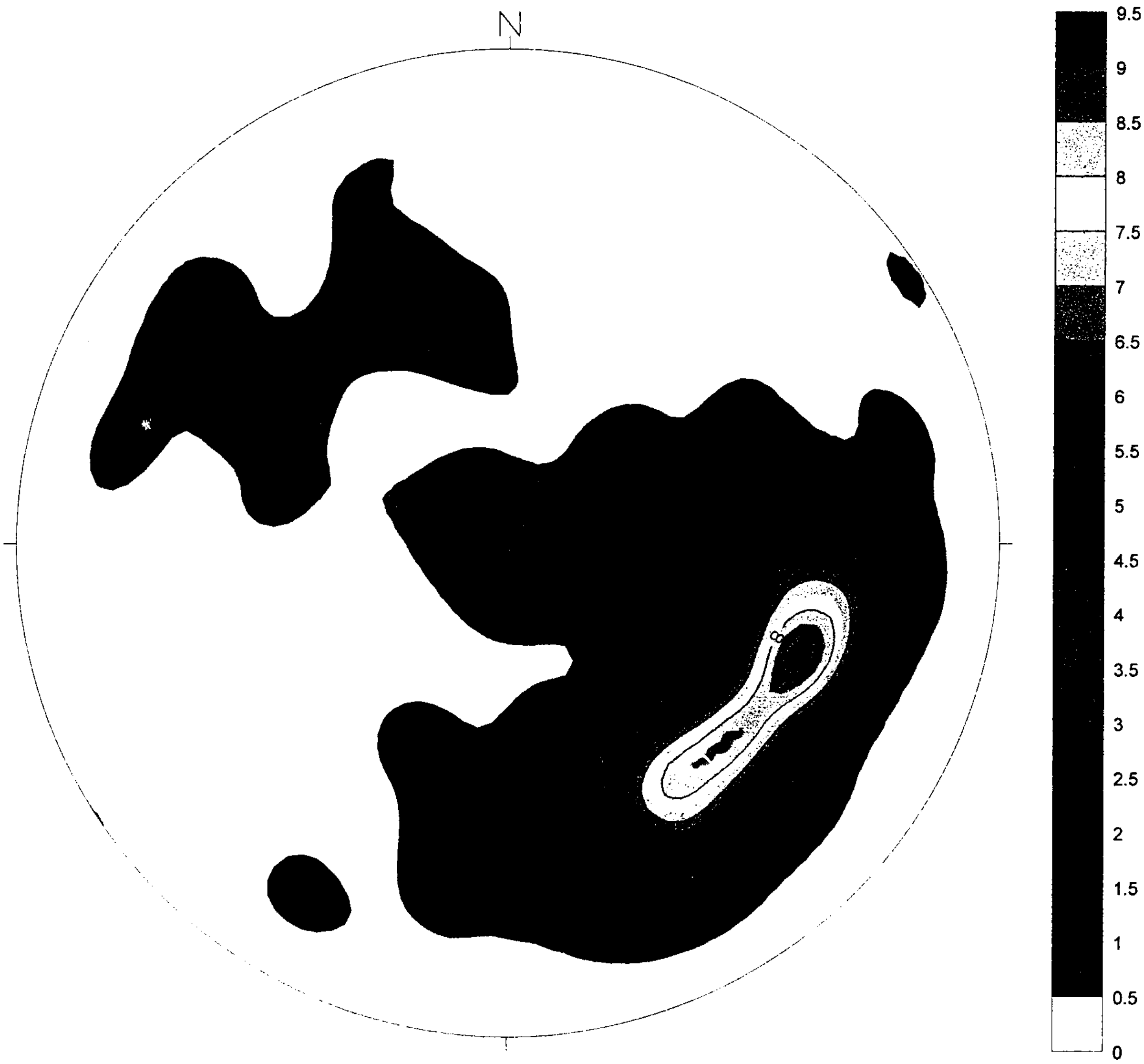
Rose Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: SB-8/MP-4
April 26, 2000

Dip Angles



Stereonet Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: SB-8/MP-4
April 26, 2000

Schmidt Projection

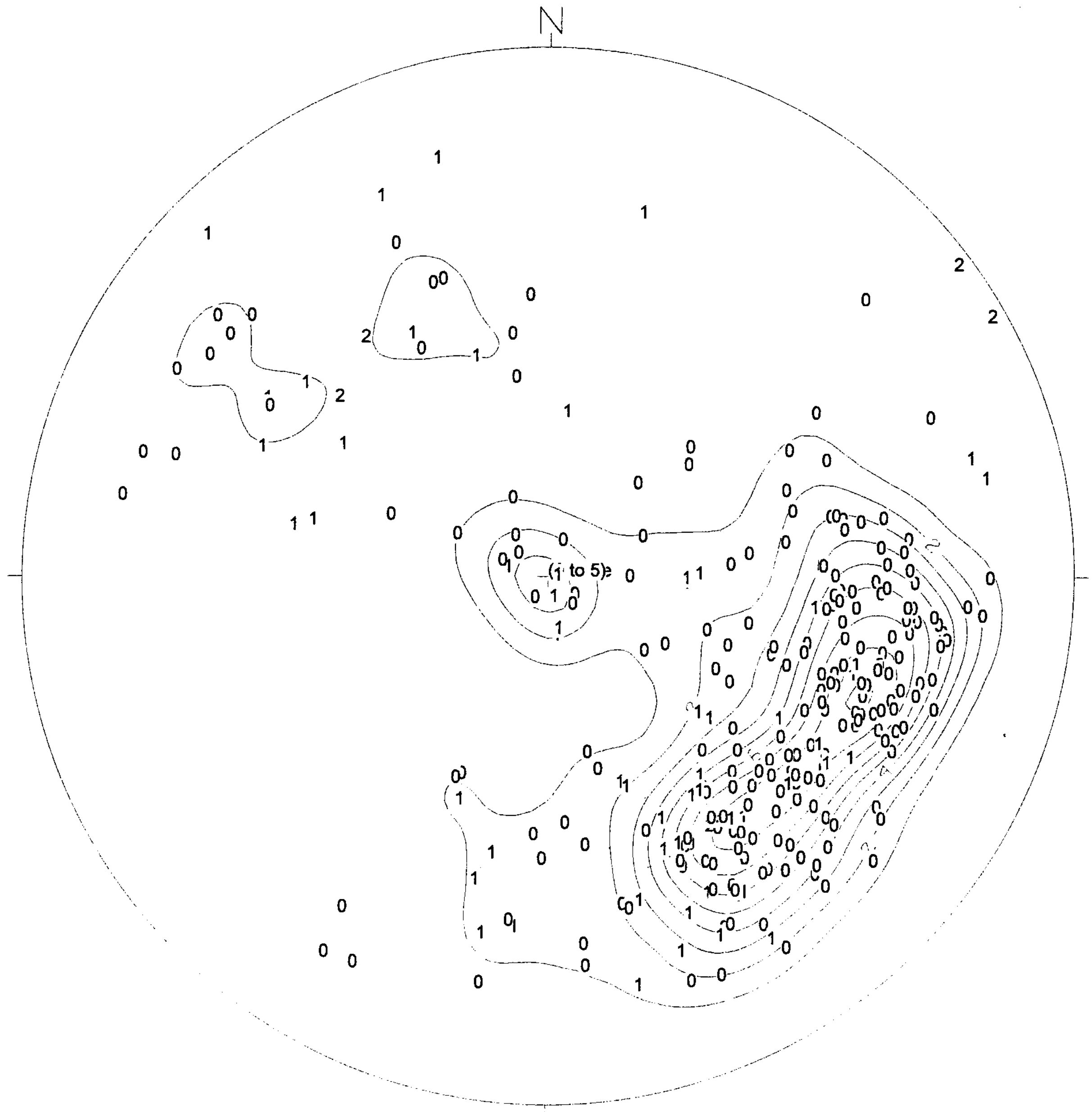


All directions are with respect to magnetic north.

COLOG

Stereonet Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: SB-8/MP-4
April 26, 2000

Schmidt Projection with Fracture Ranks



All directions are with respect to magnetic north.

GW-62BR

Orientation Summary Table
BIPS Features
Olin Wilmington, Well: GW-62BR,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
1	23.19	76.1	117	32	1
2	23.59	77.4	284	66	0
3	23.70	77.7	280	67	2
4	23.79	78.0	291	69	2
5	23.87	78.3	297	66	1
6	23.93	78.5	307	59	2
7	23.97	78.6	131	30	0
8	24.00	78.7	131	35	0
9	24.05	78.9	139	30	0
10	24.08	79.0	296	65	0
11	24.08	79.0	129	26	0
12	24.10	79.1	137	26	0
13	24.24	79.5	307	70	0
14	24.28	79.6	147	35	1
15	24.30	79.7	327	55	0
16	24.40	80.0	17	73	1
17	24.43	80.1	308	57	1
18	24.46	80.2	162	28	1
19	24.55	80.5	162	34	1
20	24.57	80.6	168	40	1
21	24.58	80.6	169	42	0
22	24.65	80.9	158	43	1
23	24.76	81.2	283	70	0
24	24.83	81.4	319	68	1
25	25.07	82.2	291	51	0
26	25.17	82.6	321	44	0
27	25.38	83.3	127	44	0
28	25.40	83.3	292	30	1
29	25.46	83.5	286	40	0
30	25.50	83.7	294	48	0
31	25.63	84.1	152	72	1
32	25.68	84.2	122	45	0
33	25.71	84.3	285	41	0
34	25.80	84.6	115	32	0
35	25.81	84.7	139	80	1
36	25.82	84.7	294	43	0
37	25.86	84.8	291	36	0
38	25.90	85.0	297	36	0
39	25.92	85.0	287	33	0
40	25.94	85.1	282	28	0
41	26.00	85.3	283	37	0
42	26.03	85.4	292	39	0
43	26.03	85.4	139	83	1
44	26.10	85.6	144	10	0

All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin Wilmington, Well: GW-62BR,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
45	26.11	85.6	287	19	0
46	26.18	85.9	289	40	0
47	26.21	86.0	289	34	0
48	26.22	86.0	114	41	1
49	26.28	86.2	137	24	0
50	26.29	86.2	296	55	0
51	26.31	86.3	136	22	0
52	26.32	86.3	148	18	0
53	26.34	86.4	285	31	0
54	26.38	86.5	134	16	0
55	26.39	86.6	293	20	0
56	26.43	86.7	283	27	1
57	26.47	86.8	290	44	0
58	26.52	87.0	109	35	0
59	26.52	87.0	293	41	0
60	26.53	87.0	112	35	0
61	26.56	87.1	113	34	0
62	26.57	87.2	296	38	0
63	26.65	87.4	115	43	0
64	26.69	87.5	123	44	0
65	26.73	87.7	300	66	0
66	26.75	87.7	125	29	0
67	26.77	87.8	125	31	0
68	26.79	87.9	300	62	0
69	26.95	88.4	289	46	0
70	27.06	88.8	146	27	0
71	27.22	89.3	289	16	0
72	27.23	89.3	313	77	0
73	27.24	89.4	121	44	0
74	27.28	89.5	124	43	0
75	27.29	89.5	290	26	0
76	27.30	89.6	127	46	0
77	27.33	89.7	290	29	0
78	27.37	89.8	287	31	0
79	27.37	89.8	124	58	0
80	27.43	90.0	289	31	0
81	27.45	90.1	136	40	0
82	27.50	90.2	286	31	0
83	27.55	90.4	292	30	0
84	27.62	90.6	290	20	0
85	27.65	90.7	296	28	0
86	27.65	90.7	121	48	0
87	27.68	90.8	297	27	0
88	27.71	90.9	120	47	0

All directions are with respect to magnetic north.

Orientation Summary Table
BIPS Features
Olin Wilmington, Well: GW-62BR,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
89	27.73	91.0	289	32	0
90	27.73	91.0	122	48	0
91	27.75	91.0	283	30	0
92	27.82	91.3	290	42	0
93	27.84	91.3	123	39	0
94	27.90	91.5	129	31	0
95	27.95	91.7	129	35	0
96	27.98	91.8	147	25	0
97	28.03	91.9	135	32	0
98	28.04	92.0	285	47	0
99	28.10	92.2	130	40	0
100	28.16	92.4	121	41	0
101	28.19	92.5	299	39	0
102	28.28	92.8	298	32	0
103	28.36	93.0	280	23	1
104	28.52	93.6	321	22	0
105	28.55	93.6	319	21	0
106	28.61	93.8	130	31	0
107	28.69	94.1	300	48	1
108	28.69	94.1	117	32	0
109	28.72	94.2	292	51	0
110	28.75	94.3	165	85	1
111	28.78	94.4	306	54	0
112	28.84	94.6	288	57	0
113	28.88	94.7	272	56	0
114	28.93	94.9	293	52	0
115	28.95	95.0	290	50	0
116	29.01	95.2	286	52	0
117	29.02	95.2	153	20	0
118	29.11	95.5	119	34	0
119	29.13	95.6	303	48	0
120	29.15	95.6	296	47	0
121	29.15	95.6	125	31	0
122	29.17	95.7	129	32	0
123	29.20	95.8	299	45	0
124	29.25	96.0	288	41	0
125	29.29	96.1	293	40	0
126	29.36	96.3	289	39	0
127	29.43	96.5	292	43	0
128	29.48	96.7	295	41	0
129	29.54	96.9	292	40	0
130	29.60	97.1	295	38	0
131	29.61	97.1	148	21	1
132	29.72	97.5	296	47	0

All directions are with respect to magnetic north.

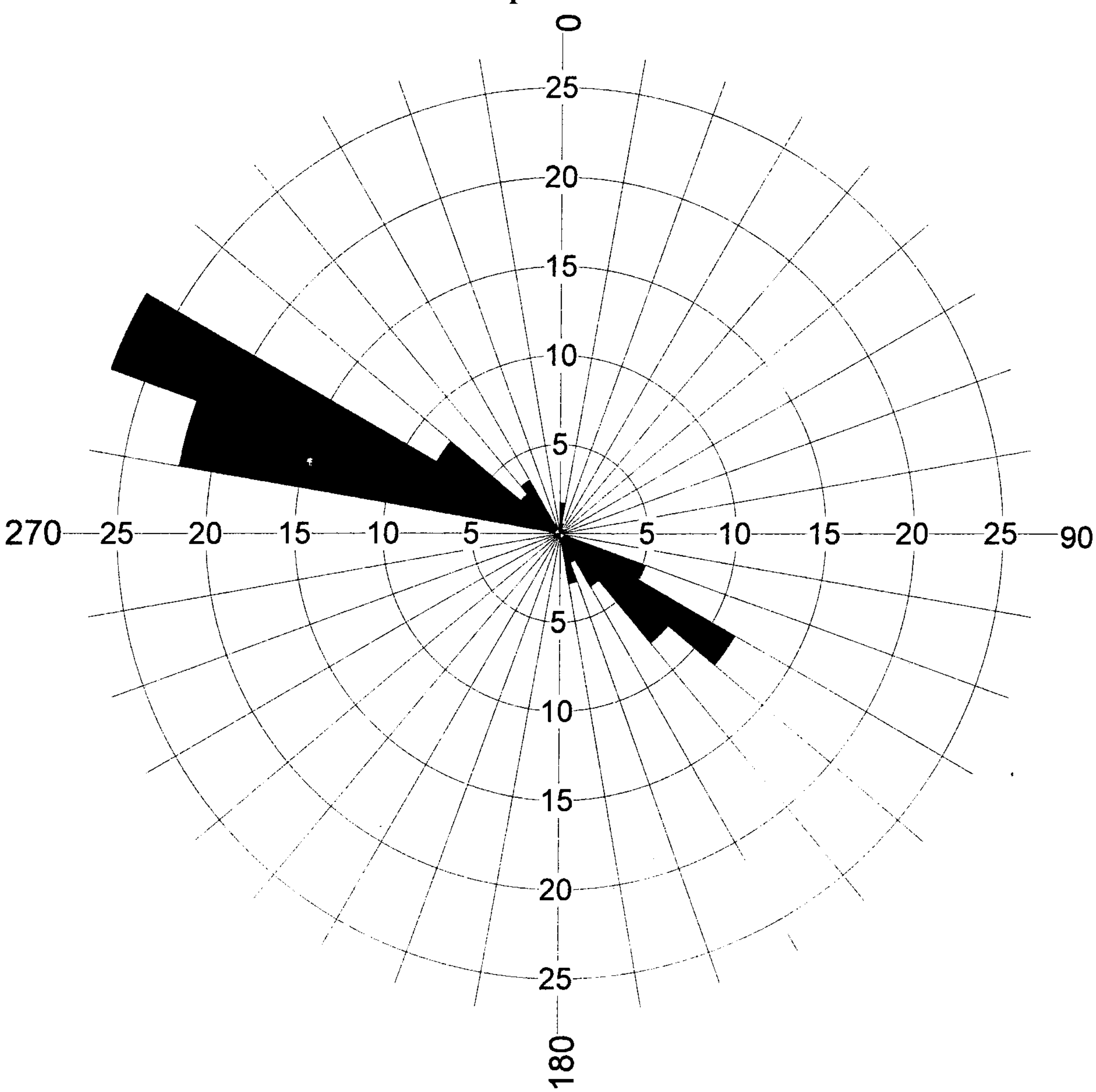
Orientation Summary Table
BIPS Features
Olin Wilmington, Well: GW-62BR,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
133	29.82	97.8	291	51	0
134	29.82	97.8	128	32	0
135	29.85	97.9	138	30	0
136	29.91	98.1	287	37	0
137	29.96	98.3	283	55	1
138	29.99	98.4	285	47	1
139	30.05	98.6	284	43	0
140	30.08	98.7	282	42	0
141	30.12	98.8	288	53	0
142	30.29	99.4	288	43	0
143	30.31	99.4	290	40	0
144	30.35	99.6	288	44	0
145	30.38	99.7	292	51	0
146	30.47	99.9	291	61	0
147	30.51	100.1	295	64	0
148	30.61	100.4	297	58	0
149	30.69	100.7	297	59	0
150	30.76	100.9	298	56	0
151	30.79	101.0	297	51	0
152	30.82	101.1	308	34	0
153	30.86	101.2	310	35	0
154	30.89	101.3	118	33	0
155	30.89	101.3	315	27	0
156	30.97	101.6	308	36	0
157	30.98	101.6	303	35	0
158	31.07	101.9	307	29	0
159	31.08	102.0	304	29	0
160	31.16	102.2	337	28	0
161	31.29	102.7	324	33	0
162	31.31	102.7	295	68	0
163	31.42	103.1	297	24	0
164	31.50	103.3	328	26	1
165	31.69	104.0	321	19	0
166	31.75	104.1	286	48	0
167	32.04	105.1	283	68	0
168	32.10	105.3	304	47	0
169	32.16	105.5	294	73	0
170	32.32	106.0	287	24	0
171	32.35	106.1	289	21	0

All directions are with respect to magnetic north.

Rose Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BR
April 26, 2000

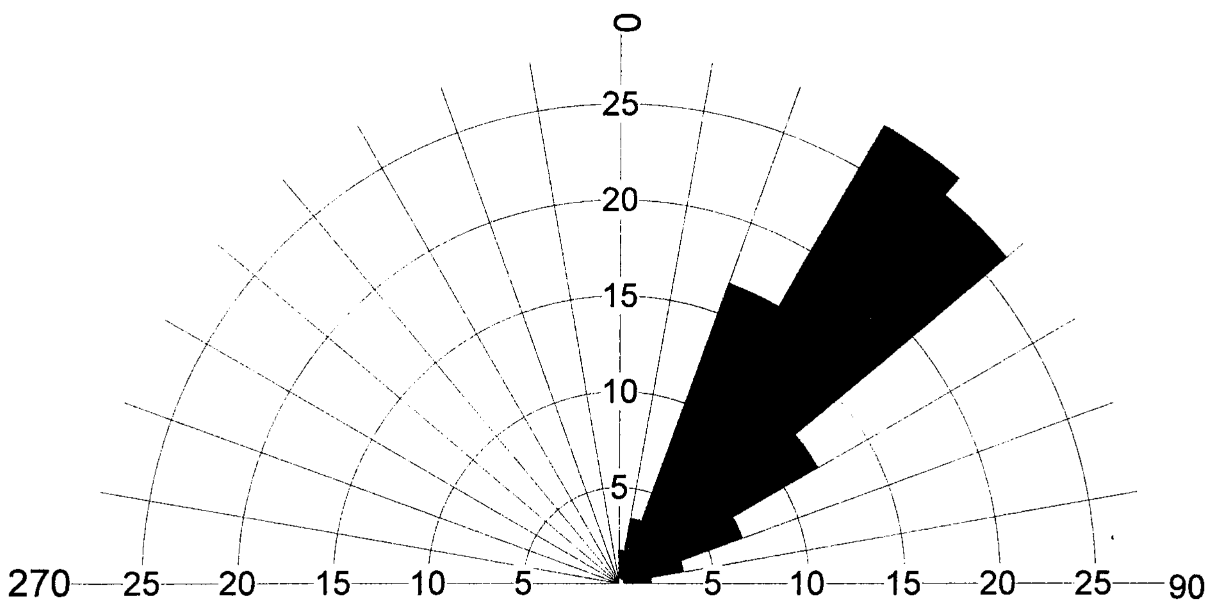
Dip Direction



All directions are with respect to magnetic north.

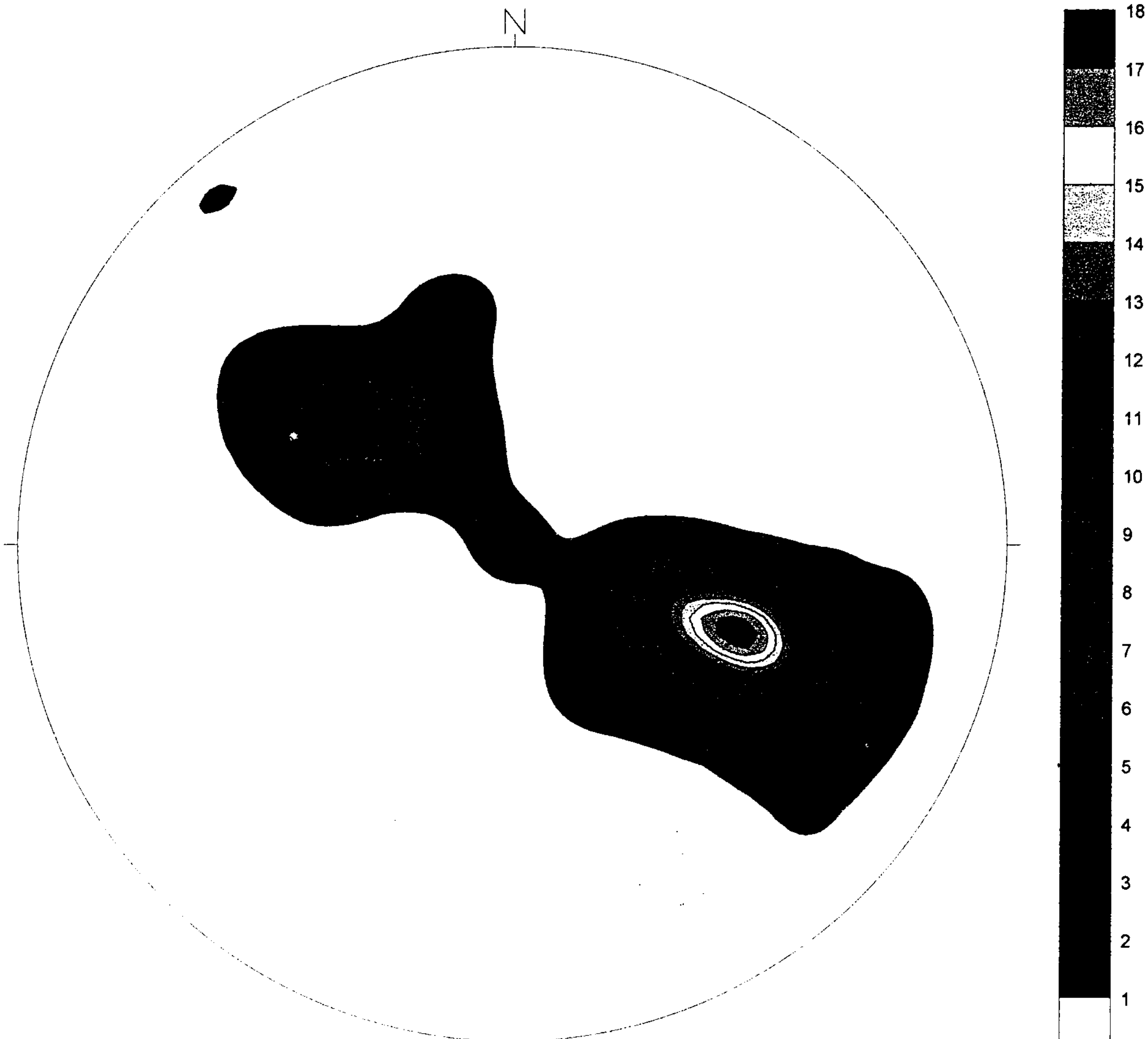
Rose Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BR
April 26, 2000

Dip Angles



Stereonet Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BR
April 26, 2000

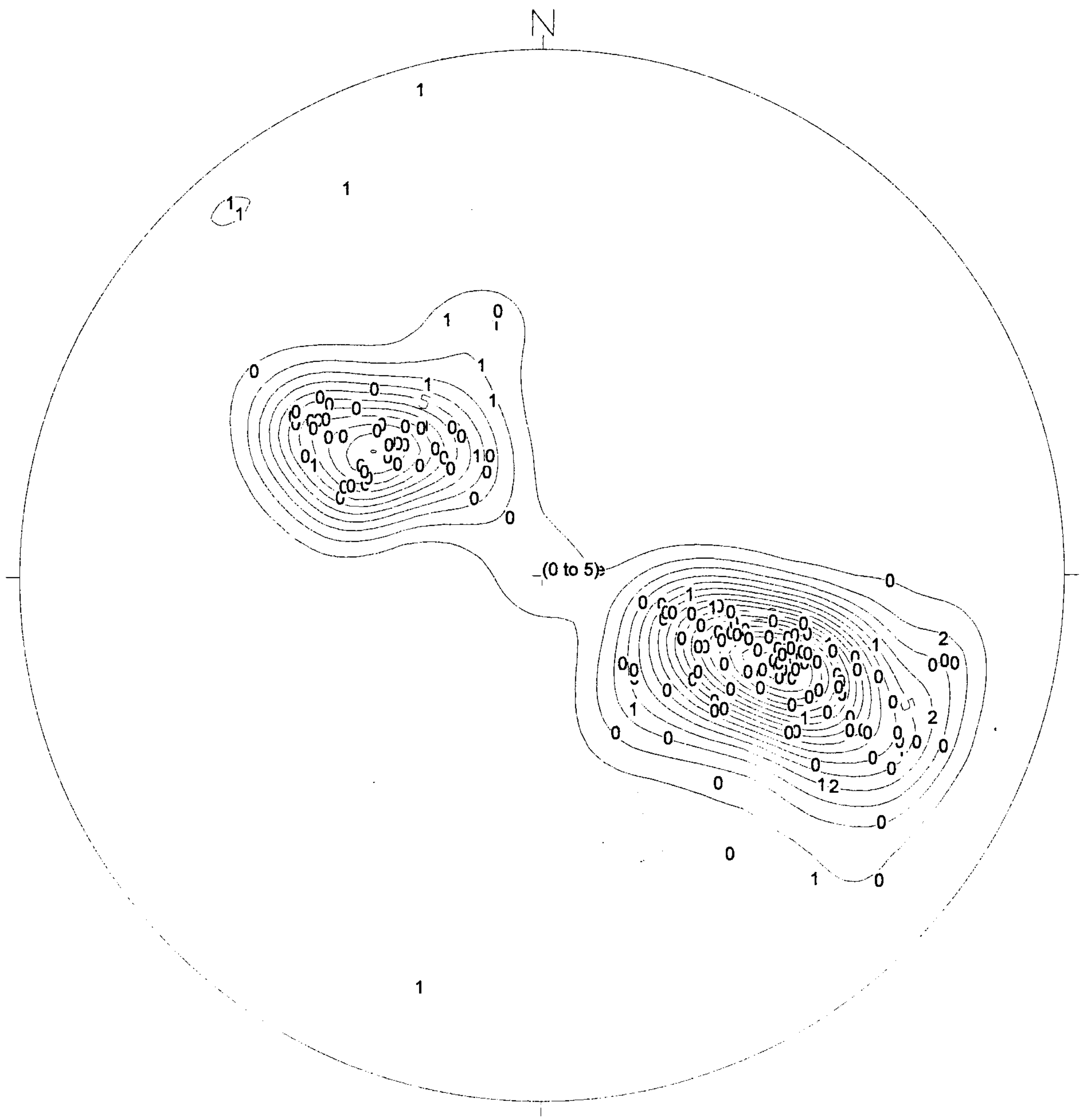
Schmidt Projection



All directions are with respect to magnetic north.

Stereonet Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BR
April 26, 2000

Schmidt Projection with Fracture Ranks



All directions are with respect to magnetic north.

GW-62BRD

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
1	32.03	105.1	175	2	0
2	32.08	105.2	314	52	0
3	32.12	105.4	314	59	0
4	32.13	105.4	318	34	0
5	32.14	105.4	82	1	0
6	32.19	105.6	116	24	0
7	32.22	105.7	93	32	0
8	32.25	105.8	3	16	0
9	32.25	105.8	121	21	0
10	32.25	105.8	311	64	1
11	32.26	105.8	312	64	0
12	32.29	105.9	131	28	0
13	32.29	105.9	321	27	0
14	32.34	106.1	310	65	0
15	32.38	106.2	313	64	0
16	32.41	106.3	109	17	0
17	32.43	106.4	62	19	0
18	32.44	106.4	313	49	0
19	32.47	106.5	313	49	0
20	32.51	106.7	315	47	0
21	32.55	106.8	313	54	0
22	32.58	106.9	315	55	0
23	32.59	106.9	124	43	0
24	32.64	107.1	125	32	0
25	32.66	107.2	328	62	0
26	32.70	107.3	151	29	0
27	32.72	107.3	318	56	0
28	32.77	107.5	308	64	0
29	32.88	107.9	297	54	1
30	32.91	108.0	290	54	0
31	32.94	108.1	296	48	0
32	32.97	108.2	140	44	0
33	32.98	108.2	318	38	1
34	33.01	108.3	320	39	0
35	33.02	108.3	144	23	0
36	33.03	108.4	141	23	0
37	33.05	108.4	139	35	0
38	33.06	108.5	307	50	0
39	33.13	108.7	308	41	0
40	33.16	108.8	312	47	0
41	33.21	109.0	306	49	0
42	33.22	109.0	140	18	0
43	33.24	109.0	136	22	0
44	33.25	109.1	316	46	0

All directions are with respect to magnetic north.

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
45	33.29	109.2	321	37	0
46	33.37	109.5	138	37	0
47	33.39	109.5	70	37	0
48	33.39	109.5	298	58	0
49	33.53	110.0	313	38	0
50	33.54	110.0	132	29	0
51	33.55	110.1	314	38	0
52	33.59	110.2	315	47	2
53	33.63	110.3	309	44	0
54	33.65	110.4	305	42	1
55	33.73	110.7	273	55	1
56	33.76	110.8	134	31	0
57	33.78	110.8	66	56	0
58	33.80	110.9	279	49	0
59	33.82	111.0	309	46	0
60	33.85	111.0	309	41	0
61	33.89	111.2	312	42	0
62	33.93	111.3	308	42	0
63	33.97	111.5	140	25	0
64	33.99	111.5	316	41	0
65	34.03	111.7	130	34	0
66	34.06	111.7	312	44	0
67	34.07	111.8	137	24	0
68	34.08	111.8	306	46	0
69	34.10	111.9	301	47	0
70	34.10	111.9	145	18	0
71	34.13	112.0	291	46	0
72	34.15	112.0	301	45	0
73	34.15	112.1	140	17	1
74	34.16	112.1	301	48	0
75	34.21	112.2	301	57	0
76	34.26	112.4	302	45	0
77	34.26	112.4	157	15	0
78	34.27	112.4	162	17	0
79	34.28	112.5	305	38	0
80	34.29	112.5	306	38	0
81	34.31	112.6	157	23	0
82	34.31	112.6	308	40	0
83	34.34	112.7	305	39	0
84	34.36	112.7	305	36	0
85	34.39	112.8	141	31	0
86	34.39	112.8	304	37	0
87	34.41	112.9	139	36	0
88	34.42	112.9	307	35	0

All directions are with respect to magnetic north.

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
89	34.44	113.0	139	34	0
90	34.45	113.0	308	32	0
91	34.47	113.1	318	31	0
92	34.51	113.2	308	31	1
93	34.52	113.2	153	17	0
94	34.57	113.4	302	57	0
95	34.62	113.6	55	53	0
96	34.64	113.6	295	17	0
97	34.65	113.7	156	21	0
98	34.66	113.7	300	67	0
99	34.69	113.8	139	34	0
100	34.70	113.8	139	23	0
101	34.73	113.9	298	51	0
102	34.74	114.0	155	19	1
103	34.77	114.1	143	21	0
104	34.78	114.1	302	56	0
105	34.85	114.3	301	55	0
106	34.93	114.6	311	56	0
107	34.99	114.8	308	50	0
108	35.03	114.9	305	53	0
109	35.09	115.1	299	50	0
110	35.14	115.3	301	43	0
111	35.18	115.4	298	46	0
112	35.23	115.6	301	44	0
113	35.28	115.7	118	70	1
114	35.28	115.8	297	46	0
115	35.31	115.9	302	46	0
116	35.34	116.0	303	48	0
117	35.38	116.1	305	45	0
118	35.41	116.2	305	43	0
119	35.43	116.2	302	42	0
120	35.44	116.3	301	41	0
121	35.47	116.4	303	37	0
122	35.51	116.5	301	40	0
123	35.55	116.6	304	43	0
124	35.58	116.7	302	49	0
125	35.63	116.9	302	47	0
126	35.67	117.0	294	52	0
127	35.71	117.1	300	51	0
128	35.74	117.3	298	53	0
129	35.79	117.4	300	57	0
130	35.84	117.6	300	48	0
131	35.87	117.7	297	45	0
132	35.91	117.8	299	50	1

All directions are with respect to magnetic north.

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
133	35.92	117.8	299	49	0
134	35.95	117.9	294	45	0
135	35.98	118.1	297	42	0
136	36.02	118.2	307	37	0
137	36.05	118.3	305	28	0
138	36.07	118.3	307	47	1
139	36.10	118.5	306	38	0
140	36.13	118.5	303	37	0
141	36.16	118.6	307	41	0
142	36.19	118.7	304	45	0
143	36.21	118.8	307	45	0
144	36.23	118.9	309	47	0
145	36.27	119.0	309	49	0
146	36.30	119.1	299	54	0
147	36.32	119.2	302	61	0
148	36.37	119.3	286	69	1
149	36.37	119.3	303	43	0
150	36.43	119.5	299	57	0
151	36.48	119.7	295	49	0
152	36.50	119.8	120	32	0
153	36.52	119.8	293	44	0
154	36.55	119.9	303	41	0
155	36.57	120.0	298	44	0
156	36.59	120.1	296	39	0
157	36.61	120.1	298	42	0
158	36.62	120.1	303	42	0
159	36.65	120.2	300	43	0
160	36.68	120.3	301	36	0
161	36.69	120.4	302	36	0
162	36.72	120.5	303	43	1
163	36.76	120.6	301	41	0
164	36.77	120.6	298	39	0
165	36.79	120.7	300	39	0
166	36.82	120.8	297	24	0
167	36.85	120.9	300	33	0
168	36.88	121.0	292	53	0
169	36.92	121.1	305	51	0
170	36.95	121.2	303	51	0
171	36.98	121.3	300	52	0
172	37.04	121.5	308	51	1
173	37.06	121.6	290	66	1
174	37.12	121.8	301	48	0
175	37.15	121.9	300	39	0
176	37.18	122.0	304	33	1

All directions are with respect to magnetic north.

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
177	37.18	122.0	307	44	0
178	37.21	122.1	310	40	0
179	37.21	122.1	161	29	1
180	37.22	122.1	310	43	0
181	37.26	122.2	302	43	0
182	37.30	122.4	148	19	0
183	37.32	122.4	305	35	0
184	37.35	122.5	314	23	1
185	37.40	122.7	149	15	1
186	37.45	122.9	308	48	1
187	37.45	122.9	139	16	1
188	37.50	123.0	307	49	1
189	37.54	123.2	305	34	0
190	37.59	123.3	304	36	1
191	37.62	123.4	298	38	0
192	37.64	123.5	178	37	1
193	37.64	123.5	299	42	0
194	37.69	123.7	303	33	0
195	37.72	123.7	299	30	1
196	37.76	123.9	303	17	0
197	37.79	124.0	301	36	0
198	37.80	124.0	152	29	0
199	37.83	124.1	299	37	0
200	37.87	124.2	155	32	1
201	37.87	124.3	297	38	0
202	37.91	124.4	157	33	0
203	37.96	124.5	293	39	0
204	38.00	124.7	293	28	1
205	38.05	124.8	294	7	0
206	38.08	124.9	300	48	1
207	38.23	125.4	293	72	0
208	38.24	125.5	143	28	0
209	38.32	125.7	293	40	0
210	38.34	125.8	152	31	0
211	38.39	125.9	134	46	0
212	38.43	126.1	304	27	0
213	38.43	126.1	308	39	0
214	38.46	126.2	304	41	0
215	38.49	126.3	300	43	0
216	38.52	126.4	293	41	0
217	38.52	126.4	131	39	0
218	38.54	126.4	299	44	0
219	38.55	126.5	305	47	0
220	38.58	126.6	138	52	0

All directions are with respect to magnetic north.

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
221	38.58	126.6	300	48	0
222	38.60	126.6	300	50	0
223	38.67	126.9	289	45	0
224	38.70	127.0	301	36	0
225	38.72	127.0	304	35	0
226	38.74	127.1	299	35	1
227	38.77	127.2	302	34	0
228	38.81	127.3	307	38	0
229	38.85	127.5	305	37	0
230	38.88	127.5	288	60	1
231	38.88	127.6	302	36	0
232	38.92	127.7	295	53	0
233	38.97	127.9	292	55	0
234	39.04	128.1	292	44	0
235	39.09	128.2	285	33	0
236	39.16	128.5	137	40	0
237	39.18	128.5	293	26	1
238	39.19	128.6	136	41	0
239	39.21	128.7	296	40	0
240	39.25	128.8	294	48	0
241	39.27	128.8	297	50	0
242	39.32	129.0	289	49	0
243	39.33	129.0	24	66	1
244	39.36	129.1	294	50	0
245	39.37	129.2	324	85	2
246	39.40	129.3	293	49	0
247	39.43	129.4	295	53	1
248	39.50	129.6	294	57	0
249	39.53	129.7	155	40	1
250	39.54	129.7	293	61	0
251	39.58	129.8	296	60	0
252	39.60	129.9	293	34	1
253	39.67	130.2	289	46	1
254	39.75	130.4	109	47	0
255	39.76	130.4	291	45	0
256	39.87	130.8	303	11	2
257	39.87	130.8	252	41	1
258	39.91	131.0	64	12	2
259	39.94	131.0	142	21	0
260	39.94	131.0	289	43	1
261	39.97	131.1	126	28	1
262	40.00	131.2	350	8	1
263	40.00	131.2	294	41	1
264	40.04	131.4	291	37	1

All directions are with respect to magnetic north.

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
265	40.08	131.5	280	17	1
266	40.12	131.6	300	23	0
267	40.19	131.8	272	25	1
268	40.23	132.0	288	44	0
269	40.28	132.2	287	49	0
270	40.30	132.2	276	42	0
271	40.34	132.3	285	57	1
272	40.39	132.5	86	16	1
273	40.42	132.6	13	57	1
274	40.42	132.6	318	25	1
275	40.48	132.8	288	41	1
276	40.53	133.0	290	48	0
277	40.58	133.1	291	49	0
278	40.59	133.2	295	70	1
279	40.73	133.6	288	53	0
280	40.76	133.7	280	43	1
281	40.81	133.9	284	45	1
282	40.85	134.0	58	27	1
283	40.87	134.1	285	48	1
284	40.91	134.2	281	50	1
285	40.92	134.2	287	49	1
286	40.94	134.3	295	50	1
287	40.95	134.4	295	51	1
288	40.96	134.4	292	54	1
289	40.97	134.4	290	55	0
290	41.01	134.5	292	59	0
291	41.09	134.8	284	47	0
292	41.09	134.8	286	47	1
293	41.10	134.8	285	47	0
294	41.12	134.9	283	48	0
295	41.17	135.1	66	24	0
296	41.19	135.1	133	40	0
297	41.20	135.2	289	47	0
298	41.21	135.2	287	46	1
299	41.21	135.2	135	23	0
300	41.23	135.3	288	44	0
301	41.24	135.3	131	36	1
302	41.26	135.4	288	37	0
303	41.30	135.5	293	59	0
304	41.34	135.6	289	56	0
305	41.35	135.7	127	39	1
306	41.37	135.7	291	58	1
307	41.39	135.8	125	48	1
308	41.45	136.0	18	35	0

All directions are with respect to magnetic north.

Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
309	41.49	136.1	289	46	0
310	41.52	136.2	288	46	0
311	41.56	136.3	292	46	0
312	41.58	136.4	128	46	0
313	41.67	136.7	122	43	0
314	41.70	136.8	293	53	0
315	41.74	136.9	124	48	0
316	41.77	137.1	130	46	0
317	41.84	137.3	24	51	0
318	41.91	137.5	14	55	0
319	41.95	137.6	288	53	0
320	42.03	137.9	292	49	0
321	42.07	138.0	286	52	0
322	42.10	138.1	293	51	0
323	42.16	138.3	294	57	0
324	42.21	138.5	294	52	0
325	42.25	138.6	294	53	0
326	42.28	138.7	289	57	0
327	42.31	138.8	293	49	0
328	42.38	139.0	293	50	0
329	42.40	139.1	294	50	0
330	42.46	139.3	294	45	1
331	42.54	139.6	289	43	0
332	42.55	139.6	114	45	1
333	42.56	139.6	119	45	1
334	42.57	139.7	121	45	1
335	42.60	139.8	291	32	1
336	42.61	139.8	305	63	1
337	42.66	140.0	282	25	0
338	42.68	140.0	133	45	0
339	42.71	140.1	293	26	0
340	42.73	140.2	286	32	0
341	42.73	140.2	282	54	0
342	42.77	140.3	276	24	0
343	42.79	140.4	281	27	0
344	42.84	140.6	282	30	0
345	42.88	140.7	282	19	0
346	42.95	140.9	281	22	0
347	43.01	141.1	284	22	0
348	43.03	141.2	286	23	0
349	43.08	141.3	290	33	0
350	43.11	141.4	36	52	0
351	43.11	141.4	285	54	0
352	43.15	141.6	290	37	0

All directions are with respect to magnetic north.

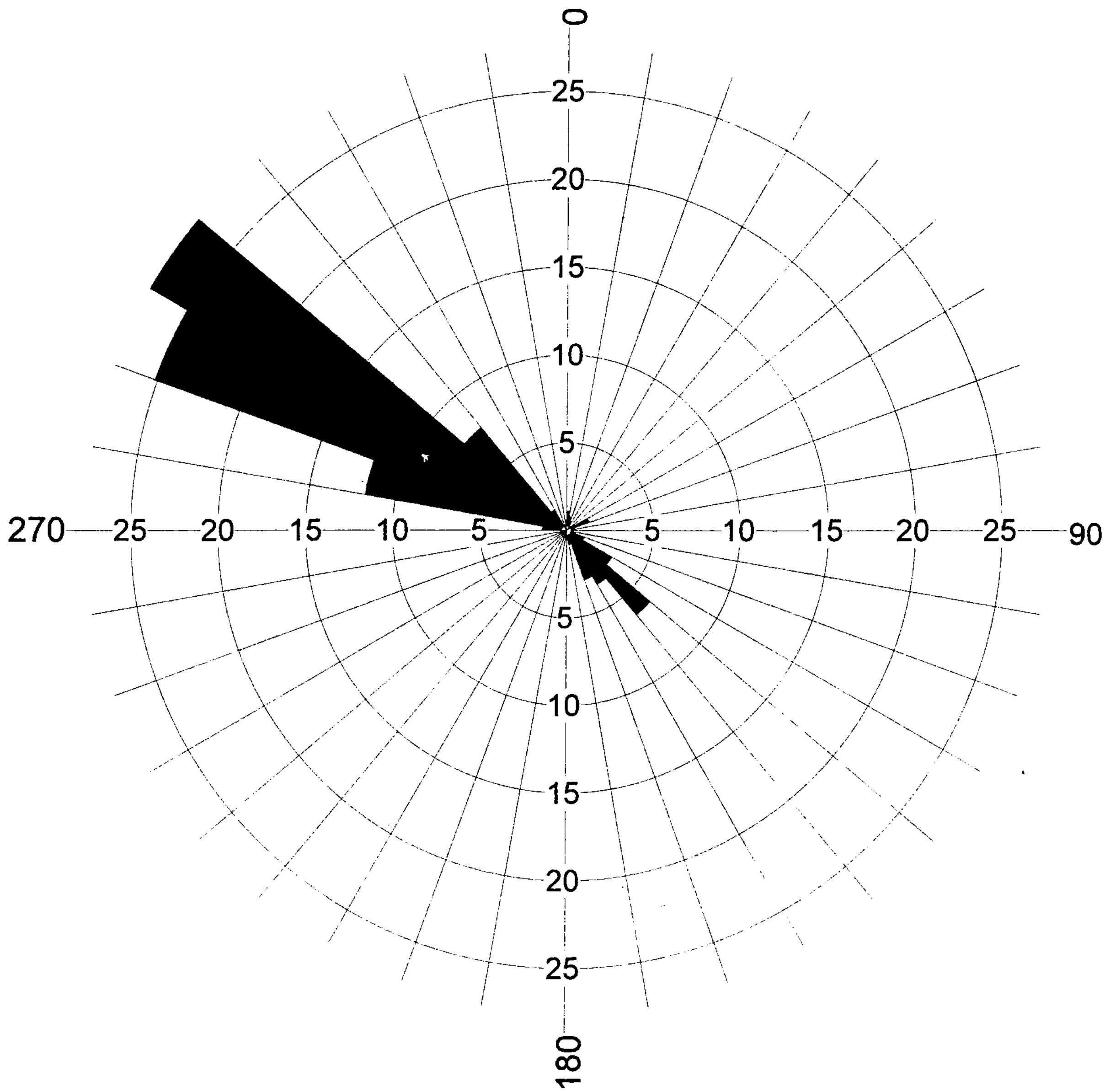
Orientation Summary Table
Olin Wilmington, Well: GW62-BRD,
Geomega
26 April, 2000

Feature No.	Depth (meters)	Depth (feet)	Dip Direction (degrees)	Dip Angle (degrees)	Feature Rank (0 to 5)
353	43.18	141.7	292	36	0
354	43.25	141.9	60	41	0
355	43.25	141.9	298	31	0
356	43.26	141.9	298	32	0
357	43.27	141.9	297	32	0
358	43.31	142.1	293	25	0
359	43.32	142.1	294	37	0
360	43.34	142.2	299	36	0
361	43.37	142.3	291	31	0
362	43.41	142.4	290	43	0
363	43.79	143.7	163	86	1

All directions are with respect to magnetic north.

Rose Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BRD
April 26, 2000

Dip Direction

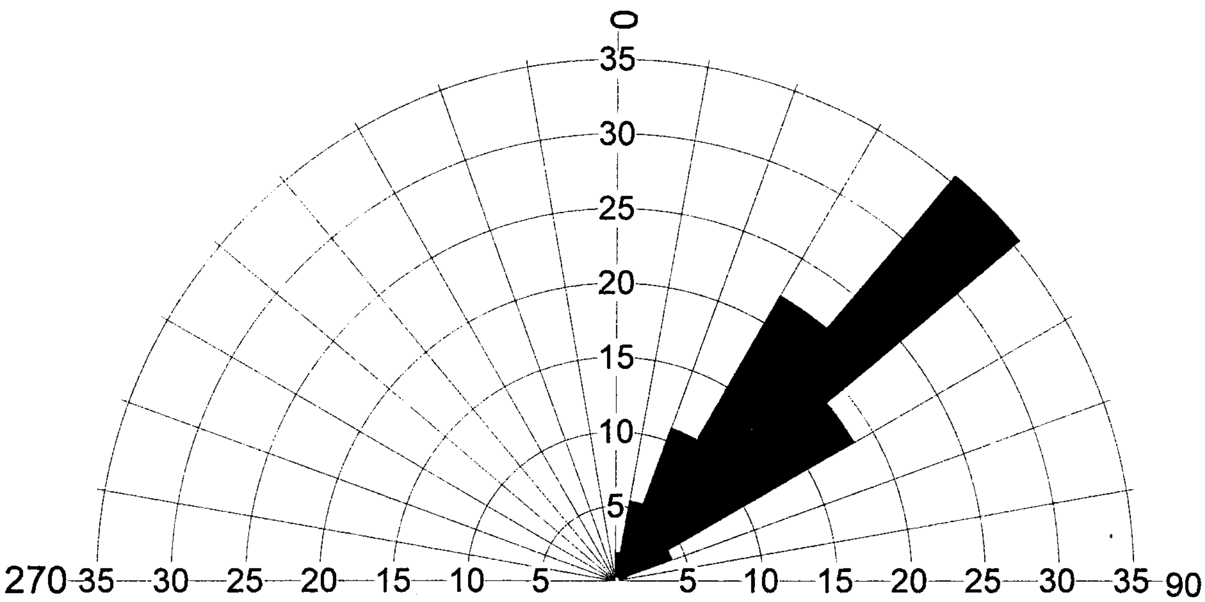


All directions are with respect to magnetic north.

COLOG

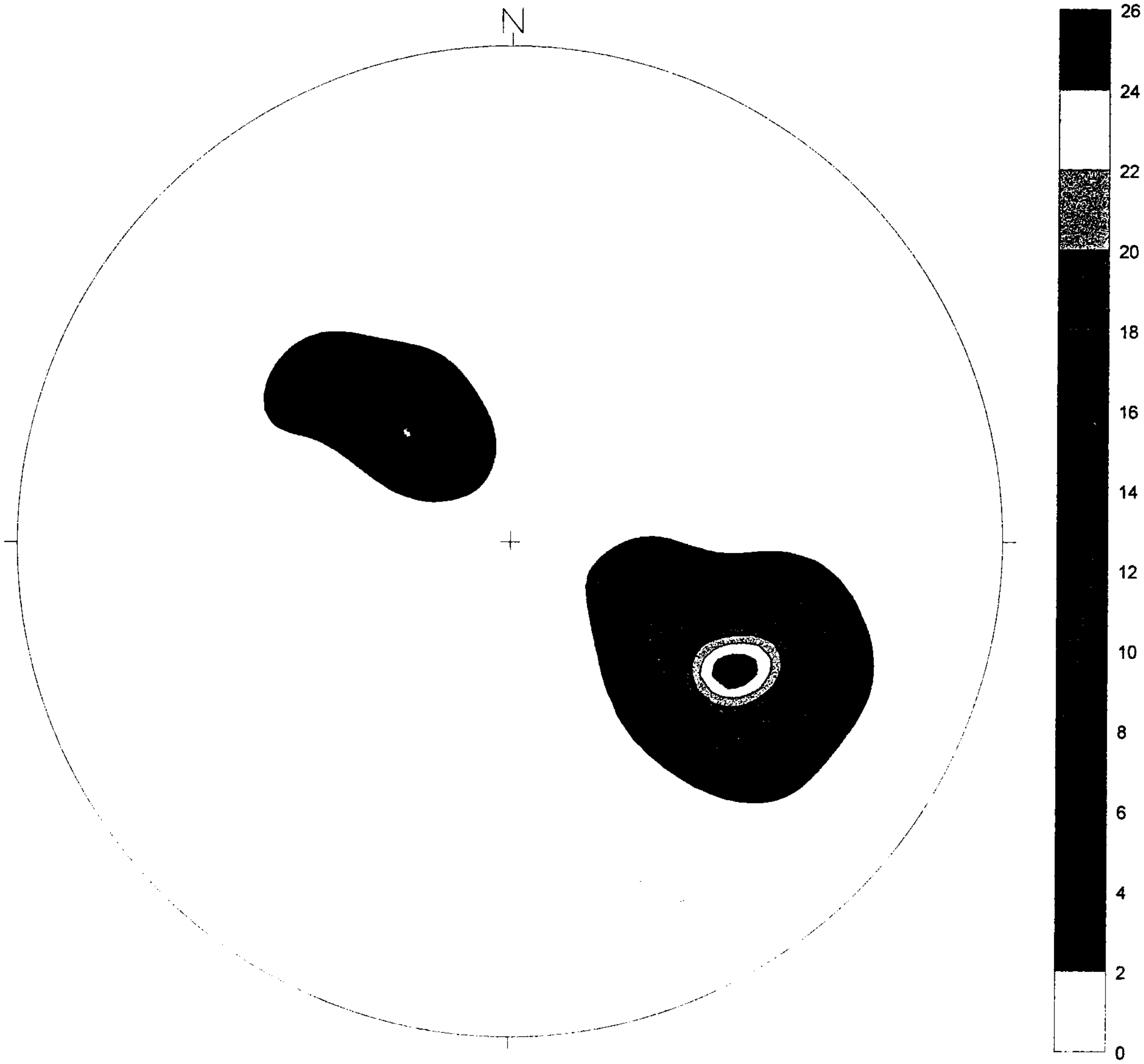
Rose Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BRD
April 26, 2000

Dip Angles



Stereonet Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BRD
April 26, 2000

Schmidt Projection



All directions are with respect to magnetic north.

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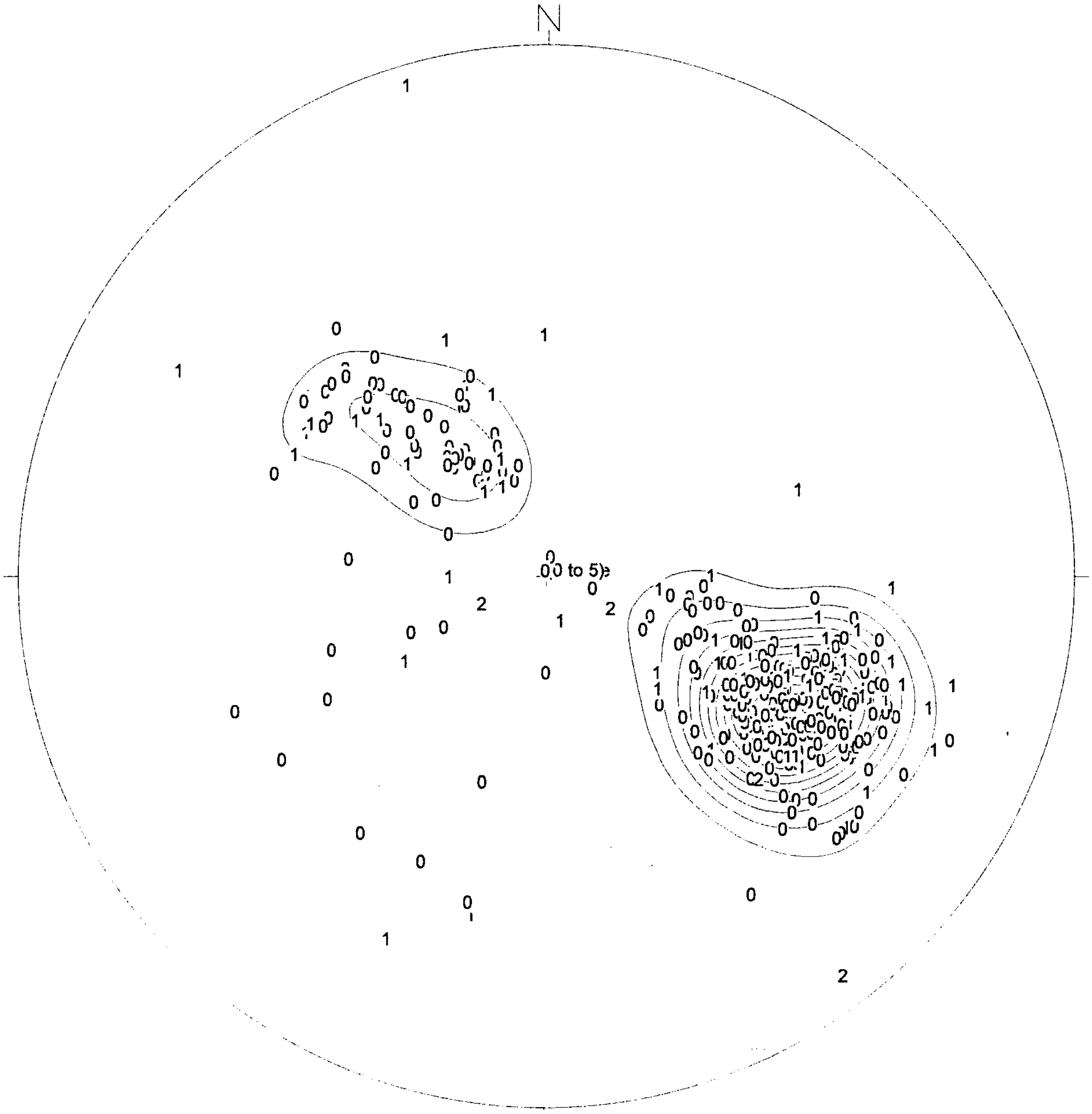
Stereonet Diagram of BIPS Features
Geomega, Olin, Wilmington Project
Well: GW62-BRD
April 26, 2000

Schmidt Projection with Fracture Ranks



All directions are with respect to magnetic north.

Appendix D

HYDROPHYSICAL™ LOGGING RESULTS
OLIN, WILIMGTON PROJECT
WILMINGTON, MASSACHUSETES

Prepared for
Geomega
August 28, 2000

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HYDROPHYSICAL™ LOGGING RESULTS
OLIN, WILIMGTON PROJECT
WILMINGTON, MASSACHUSETES

1.0 Executive Summary

COLOG's services were employed to apply HydroPhysical™ logging methods to characterize the formation waters of 3 well borings located at the Olin, Wilmington site in Wilmington, Massachusetts. The 3 well borings tested are: SB-8/MP-4, GW-62BR and GW-62BRD. The objectives of the investigation were to:

1) Evaluate temperature and fluid electrical conductivity under pre-testing conditions.
2) Identify and quantify flow in the wellbores under non-pumping, or ambient, conditions.
3) Identify and quantify inflow to the wellbores under separate pumping, or stressed, conditions.
4) Quantify fracture-specific hydraulic conductivity and transmissivity for all producing zones identified.

The results of the HydroPhysical™ logging performed in the subject well borings identified numerous water-bearing zones in each wellbore ranging from dominant to minor in flow. The majority of wellbores, however, had overall low yields (specific capacities ranged from 0.005 to .190 gpm/foot drawdown). Fluid electrical conductivity (FEC) ranged greatly among boreholes and among individual intervals within the wellbores. The maximum FEC was observed in wellbore SB-8/MP-4 at 15,230 and similarly in GW-62BR at 15,160 µS/cm. Ambient testing on all three wellbores identified horizontal flow in wellbores SB-8/MP-4 and GW-62BRD, with GW-62BR exhibiting downward vertical flow. Wellbore GW-62BRD exhibited very little ambient flow. Ambient vertical gradients observed in the wellbores do not necessarily reflect water movement outside the influence of the wellbore.

Production tests were performed on each of the three wellbores at pump rates ranging from 0.9 to 1.2 gpm, depending on well yield and drawdown. In two of the three wells tested, the dominant producing zone was at or near the top of the wellbore. Only in GW-62BRD was the dominant flow zone located at the bottom of the wellbore. Interval-specific transmissivities ranged from 0.012 to 8.81 feet^2/day with wellbore SB-8/MP-4 exhibiting the group of highest T values and GW-62BR the group of lowest T values.

Wellbore	Ambient Vertical Gradient	Production Rate gpm/Drawdown (gpm/ft)	Highest FEC (µS/cm)	Highest Transmissivity (feet^2/day)
SB-8/MP-4	Horizontal	1.24/6.54'	15,230	8.81
GW62-BR	Downward	0.17/35.80'	15,160	0.436
GW62-BRD	Horz. & Down	0.79/51.75'	9,549	0.878

Please refer to Tables SB-8/MP-4:1, GW-62BR:1 and GW-62BRD:1 for a complete summary of the HydroPhysical™ results along with transmissivity estimates and interval-specific FEC.

2.0 Introduction

In accordance with COLOG's proposal dated March 26, 1999, COLOG has applied HydroPhysical™ logging (HpL™) methods to characterize the formation waters of three wellbores at the Olin, Wilmington site in Wilmington, Massachusetts. Along with the HydroPhysical™ logging, BIPS (Borehole Image Processing System) and density logs were also performed.

COLOG's logging of the 3 wellbores was performed over April 27-29, 2000.

3.0 Methodology

The HydroPhysical™ logging technique involves pumping the well and then pumping while injecting into the well with deionized water (DI). During this process, profiles of the changes in fluid electrical conductivity of the fluid column are recorded. These changes occur when electrically contrasting formation water is drawn back into the wellbore by pumping or by native formation pressures (for ambient flow characterization). A downhole wireline HydroPhysical™ tool, which simultaneously measures fluid electrical conductivity (FEC) and temperature is employed to log the physical/chemical changes of the emplaced fluid.

The computer program BORE (Hale and Tsang, 1988) can be utilized to evaluate the inflow quantities of the formation water for each specific inflow location. Numerical modeling of the reported data is done using code BORE. BORE was developed in conjunction with the DOE and Lawrence Berkeley National Labs for accurately modeling the changes in conductivity observed in a wellbore.

In addition to conducting HydroPhysical™ logging for identification of the hydraulically conductive intervals and quantification of the interval specific flow rates, additional logging runs are also typically performed. Prior to emplacement of DI, ambient fluid electrical conductivity and temperature (FEC/T) logs are acquired to assess the ambient fluid conditions within the wellbore. During these runs, no pumping or DI emplacement is carried out, and precautions are taken to preserve the existing ambient geohydrological and geochemical regime. These ambient water quality logs are performed to provide baseline values for the undisturbed wellbore fluid conditions prior to testing.

4.0 HYDROPHYSICAL™ LOGGING RESULTS - WELL SB-8/MP-4

4.1 Ambient Fluid Electrical Conductivity and Temperature Log: SB-8/MP-4

At 1430 hours on April 27, 2000, after a calibration check of the fluid electrical conductivity (FEC) and temperature logging tool, the fluid column was logged for FEC and temperature profiles with COLOG's 1.5-inch diameter HpL™ tool. These logs were performed prior to the installation of any pumping equipment. Please refer to Figure SB-8/MP-4:1. The ambient FEC/T profiles indicate a change in FEC and temperature at a depth of 128.7 to 140.5 and at 153.1 to 157.2 feet, suggesting a dynamic, or flowing, condition in the borehole at these depths. In vertically flowing conditions, where water enters the borehole, termed inflow, a change in either FEC and/or temperature is typically seen.

4.2 Ambient Flow Characterization: SB-8/MP-4

On April 27, 2000, ambient flow characterization was conducted in SB-8/MP-4. For ambient flow assessment, the formation water in the wellbore was diluted with deionized water (DI) and the well left in an undisturbed state to allow any natural flow to occur. The pump was removed from the well to insure that water in the pump standpipe would not drain back into the well. Prior to this period and throughout all HpL™ testing, water levels were monitored and recorded. Ambient flow evaluation is reported for the period after the water surface returned to near pre-emplacement levels. A series of FEC and temperature logs were then conducted to identify changes in the fluid column associated with ambient flow. In addition to vertical flow characterization, the presence of horizontal flow was evaluated.

On April 27, 2000, at 1635 hours (T=0.00 minutes, elapsed time of test), dilution of the fluid column was complete. Minimal to no DI water was lost to the formation due to the slightly depressed head during emplacement procedures. During the 2.05 hours following dilution, multiple logs were conducted. Of these logs, 6 are presented in Figure SB-8/MP-4:2. Only logs acquired during logging in the downward direction are presented as the design of the FEC/T probe allows for the most accurate data to be collected in the downward direction. The logs acquired in the upward logging direction are not representative of downhole conditions and are therefore omitted. These logs illustrate significant change at several intervals throughout the length of the borehole. These dramatic changes in the FEC profiles with respect to time are associated with ambient flow occurring within these intervals.

A tessellated[1] chromographic summary of all downward FEC traces is presented in Figure SB-8/MP-4:3. FEC of 0 μS/cm is represented on this figure by the dark blue color, with a spectral color progression to red as the values increase linearly to 800 μS/cm.

Formation water migration caused by vertical flow within the fluid column is indicated by the chromatically defined lineaments in Figure SB-8/MP-4:3 for the intervals from 99.4 to 99.7 feet, 140.0 to 142.1 feet, 143.7 to 146.4 feet, and 153.1 to 157.2 feet. Direct interpretation of the data for these intervals suggests that horizontal flow is occurring in each of these intervals with flow rates of 0.0007 gpm, 0.001 gpm, 0.0005 gpm, and 0.003 gpm, respectively. Horizontal flow velocities for these intervals were observed to be 0.007, 0.0015, 0.0005 and 0.002 feet/day within the borehole, respectively. Correcting for convergence to a wellbore (*Drost, 1968*), this equates to a specific discharge of the aquifer of 0.0028, 0.0006, 0.0002 and 0.0009 feet/day. The depth to water at the time of ambient flow testing was 16.67 feet below top of casing (fbtoc).

[1] Referring specifically to the mosaic coloration of FEC values between traces.

4.3 Flow Characterization During 1.2 GPM Production Test: SB-8/MP-4

Pumping of wellbore fluids after emplacement of DI water was conducted at one pumping rate to establish the inflow locations and evaluate the interval specific inflow rates and FEC. Pumping at a given rate was conducted after dilution until numerous FEC/Temperature logs were acquired and the well characterized. These procedures were conducted at a pumping rate of 1.24 gpm.

On April 28, 2000, at 1003 hours (T = 0.0 minutes elapsed time of testing), pumping was initiated at about 1.2 gpm. Prior to initiating pumping, the depth to water was recorded at 16.67 fbtoc. All drawdown values are referenced to this ambient water level. Time dependent depth to water, totals and flow rate information were recorded and are presented in Figure SB-8/MP-4:4. Pumping was maintained at a time-averaged rate of 1.24 gpm until 1218 hours (T = 135 minutes, elapsed time of testing). During pumping, a reasonably constant drawdown of about 6.54 feet was observed. COLOG defines reasonably constant drawdown as drawdown that fluctuates less than 10 percent of the total drawdown. During pumping, twelve FEC logs were acquired and are presented in Figure SB-8/MP-4:5 with the first log acquired during dilution of the borehole. The logs show inflow entering the borehole at each of the marked increases in FEC. The water entering the borehole is observed to be moving upwards toward the pump inside casing. The nomenclature for the logs is a series of time tags. The last four digits of each log ID corresponds to the time at which that particular log was started. Nine inflow zones were identified from these logs with flow rates ranging from 0.087 to 0.265 gpm. The logs indicate the majority of inflow coming from the top of the borehole at 75.0 to 86.0 feet. Please refer to Table SB-8/MP-4:1 for a summary of flow results and the depths of individual inflow zones.

4.4 Estimation of Interval Specific Hydraulic Conductivity: SB-8/MP-4

An estimation of horizontal hydraulic conductivity (K) can be made using an equation after Hvorslev (1951) assuming steady-state radial flow in an unconfined aquifer:

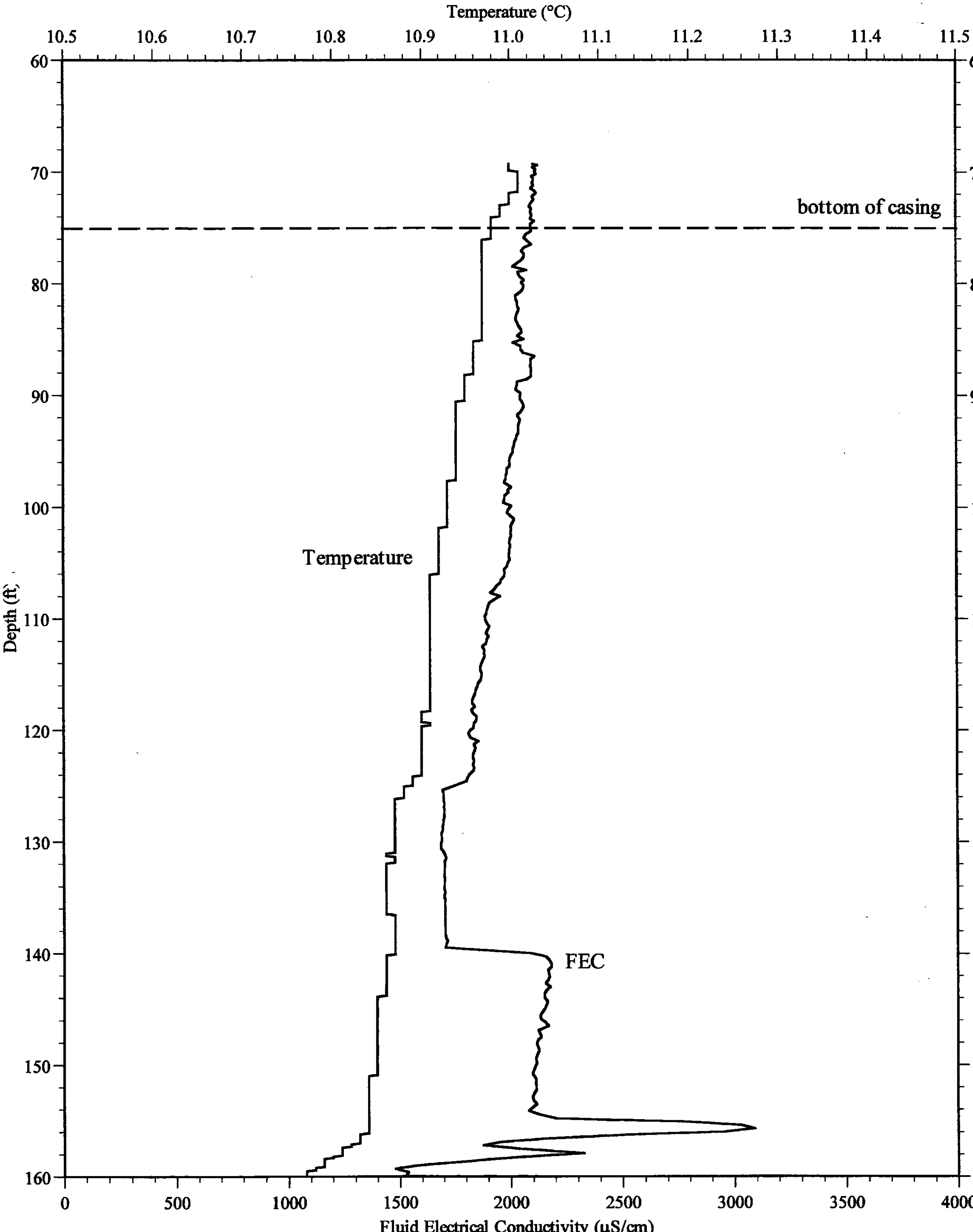
$$T = KL = \frac{q_i}{2\pi \Delta h_w} \ln\left(\frac{r_e}{r_w}\right)$$

where K is the hydraulic conductivity, q_i is the interval specific inflow rate calculated by HpL™ results, r_w is the borehole radius (0.17 ft), r_e is the effective pumping radius , Δh_w is the observed maximum drawdown (6.54 feet) and L is the thickness of the zone through which flow occurs. For our calculations, COLOG used r_e of 200 feet (assumed). By applying L and q_i from the HpL™ results under the two pressure conditions, the interval specific hydraulic conductivity can be calculated for each identified water producing interval. These calculations were made at each identified interval and are presented in Table SB-8/MP-4:1.

4.5 Data Interpretation: SB-8/MP-4

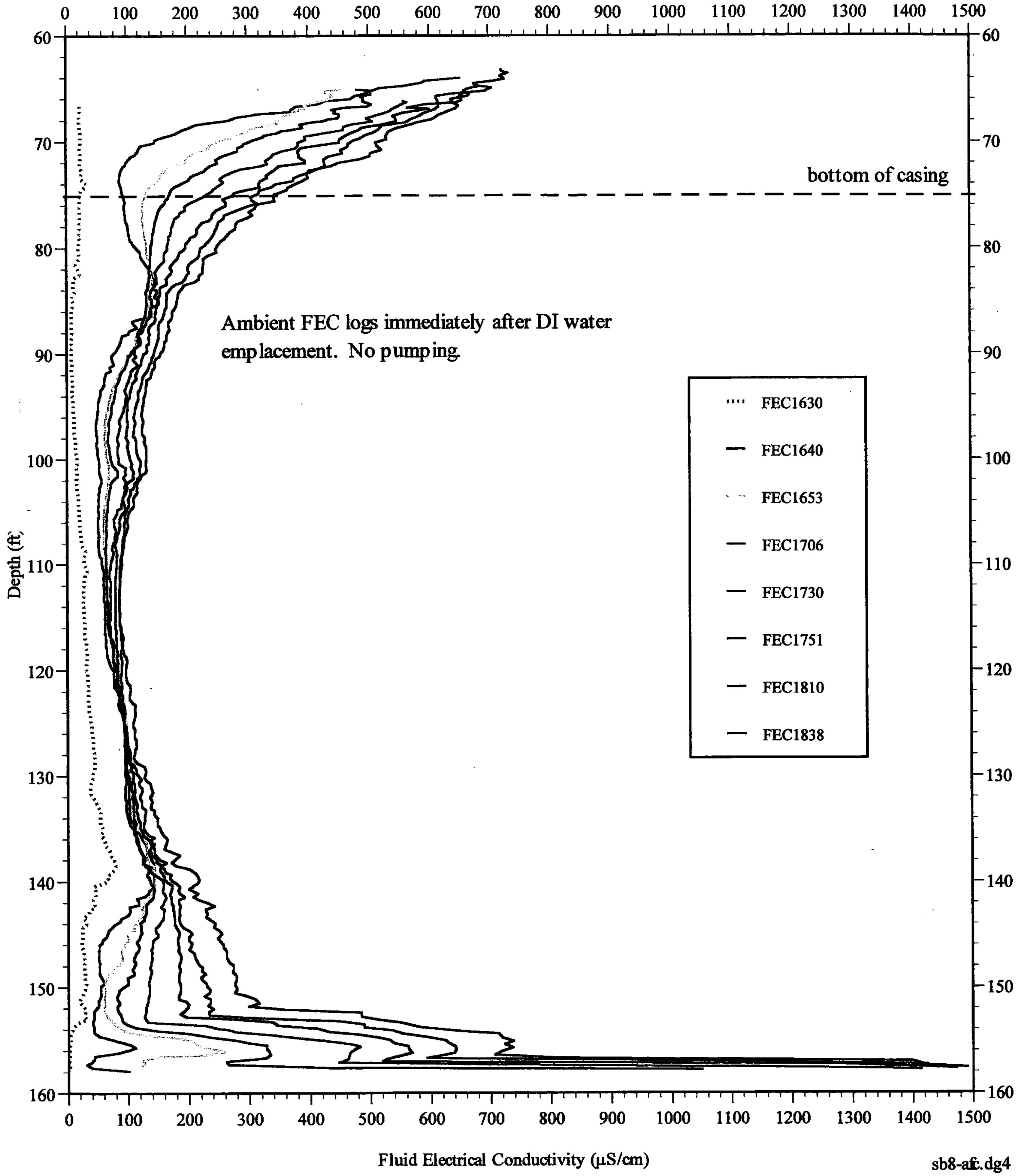
Processing and interpretation of the HydroPhysical™ logs obtained during pumping (Figure SB-8/MP-4:5) suggest the presence of 9 producing intervals for this wellbore. Numerical modeling of the reported field data was performed using the computer program BORE. Analyses were performed to estimate the rate of inflow for each identified hydraulically conductive wellbore interval during DI injection procedures. The results of these analyses are presented Table SB-8/MP-4:1. In summary, the interval 84.2 to 86.0 feet dominated inflow during the production test at 1.24 gpm. This interval contributed 0.265 gpm or 20.96 percent of the total flow during the 1.24 gpm production test. One other interval contributed moderate flow at 75.0 to 79.1 feet, contributing 0.205 gpm, or 16.5 percent of the total production. The other 7 intervals contributed the remaining 0.794 gpm (64.0%). During ambient testing, well SB-8/MP-4 exhibited a relatively simple ambient flow scenario. All ambient flow was observed to be horizontal, with the majority of flow originating at the interval 153.1 to 157.2 feet. Horizontal flow for this interval was observed to be 0.002 feet/day (0.003 gpm). Correcting for convergence to a wellbore (Drost, 1968) this equates to a specific discharge of the aquifer of 0.0009 feet/day. Interval-specific transmissivities in SB-8/MP-4 ranged from 2.86 to 8.81 $feet^2/day$ with the interval of 84.2 to 86.0 feet registering the highest transmissivity. Aside from the highest T value, the remaining eight interval-specific transmissivity estimates did not differ significantly with respect to each other. Interval-specific FEC ranged from 7,989 to 15,230 μS/cm, with the highest FEC originating from the interval 153.1 to 157.2 feet. Differential FEC, the lack of a significant pressure differential within a borehole and similar T values are all suggestive of an inter-connected fracture network or aquifers in the region of the wellbore. Please see Table SB-8/MP-4:1 for a summary which includes the locations and rates of inflow and transmissivity estimates assessed by COLOG.

FIGURE SB-8/MP-4:1. AMBIENT TEMPERATURE AND FLUID ELECTRICAL CONDUCTIVITY; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL SB-8/MP-4



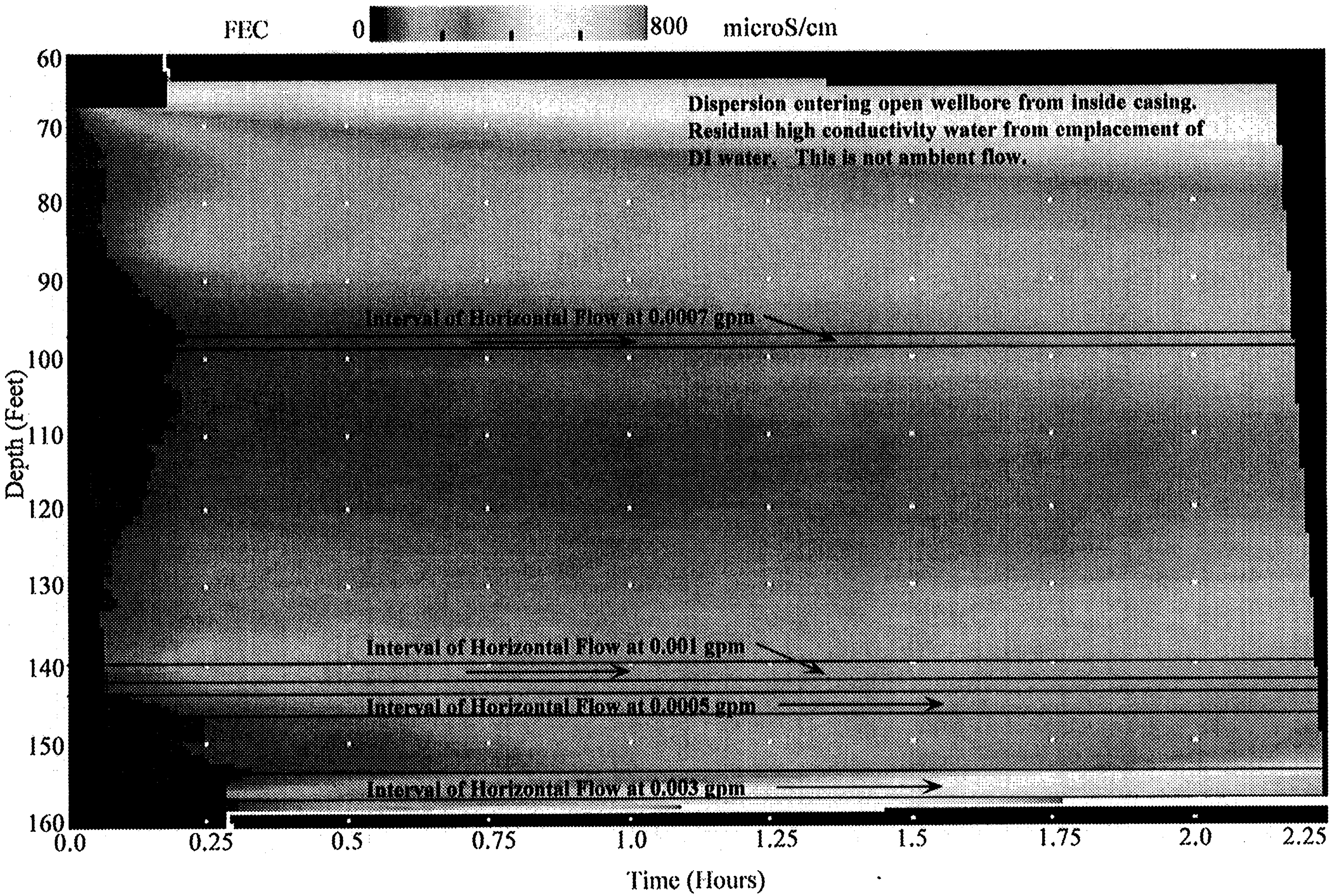
sb8-abff.dg4

FIGURE SB-8/MP-4:2. SUMMARY OF HYDROPHYSICAL LOGS DURING AMBIENT FLOW CHARACTERIZATION; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL SB-8/MP-4



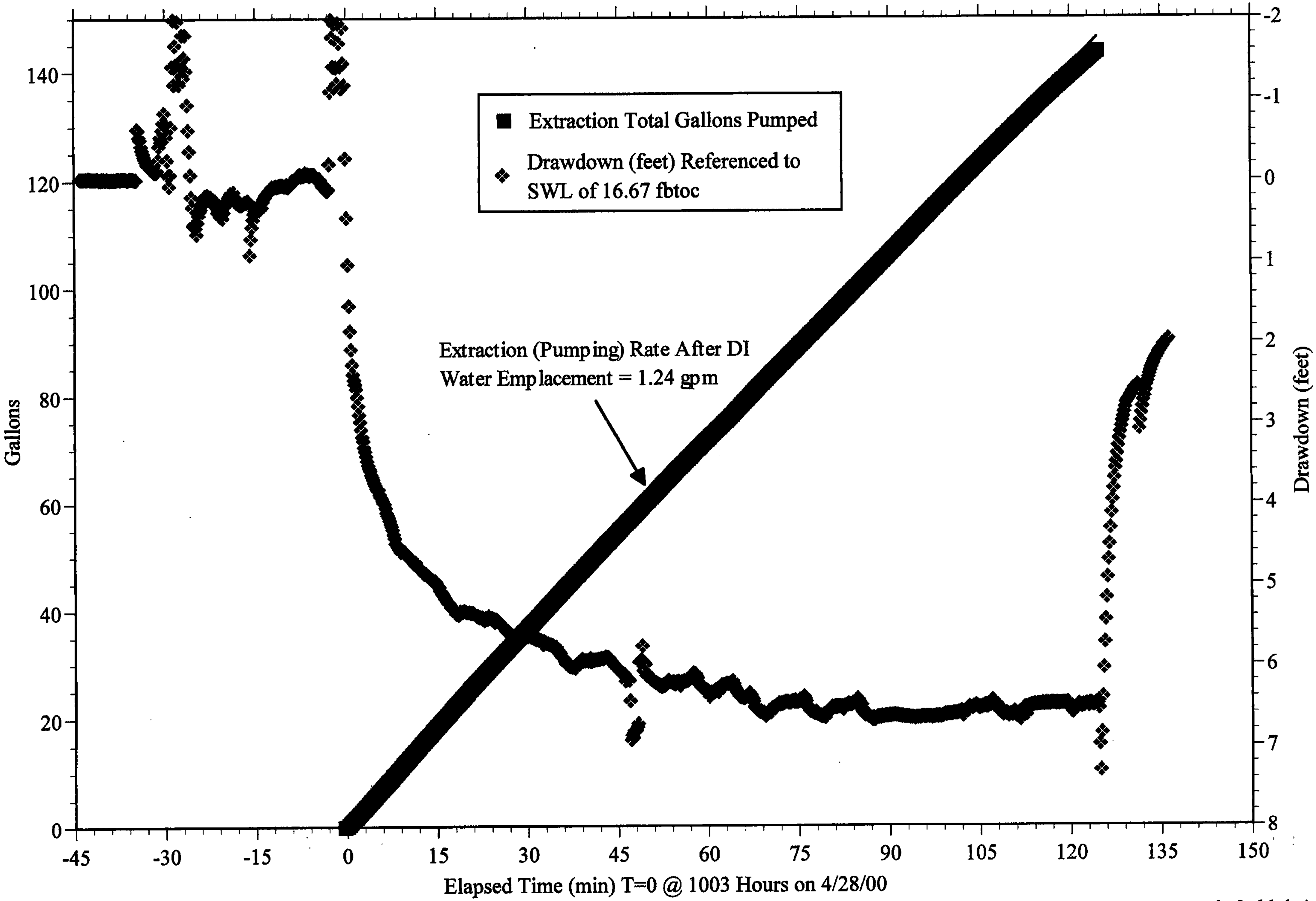
sb8-afc.dg4

FIGURE SB-8/MP-4:3. CHROMOGRAPHIC TESSELLATION OF FEC LOGS DURING AMBIENT FLOW CHARACTERIZATION; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL SB-8/MP-4



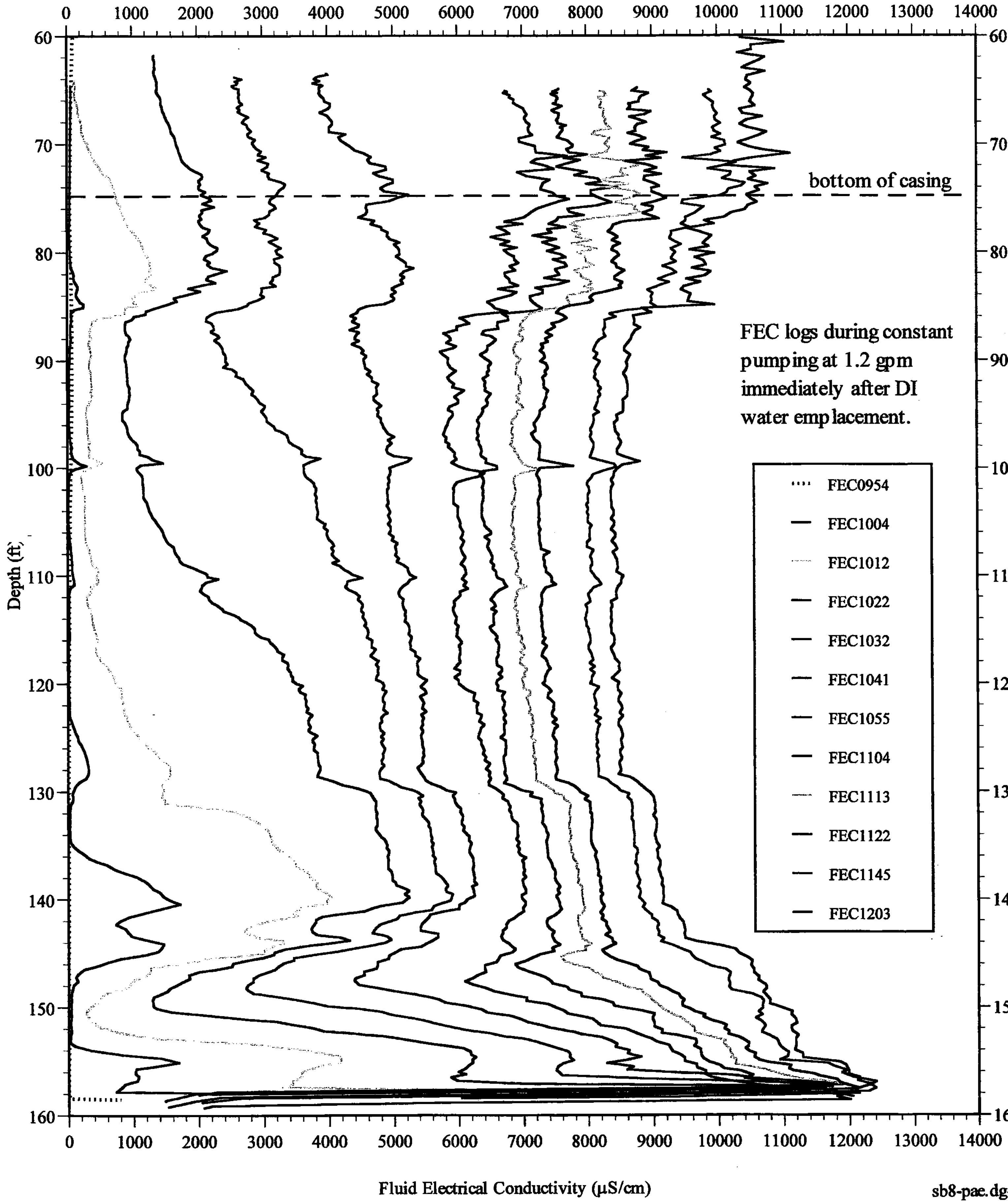
sb8-afc.cvs

FIGURE SB-8/MP-4:4. PUMPING AND DRAWDOWN DATA FOR 1.2 GPM TEST; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL SB-8/MP-4



sb-8-dd.dg4

FIGURE SB-8/MP-4:5. SUMMARY OF HYDROPHYSICAL LOGS DURING LOW RATE PUMPING AT 1.2 GPM AFTER DI WATER EMPLACEMENT; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL SB-8/MP-4



sb8-pae.dg4

TABLE SB-8/MP-4:1. SUMMARY OF HYDROPHYSICAL™ LOGGING RESULTS WITH HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY ESTIMATIONS; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL SB-8/MP-4

Project and Well name	Olin, Wilmington Project, Well: SB-8/MP-4
Ambient Depth to water (ft)	16.67
Diameter of Borehole (ft)	0.33
Maximum Drawdown (ft)	6.54
Effective Radius (ft)	200
Formation Production Rate (gpm	1.24

Well SB-8/MP-4 Interval No.	Top of Interval (ft)	Bottom of Interval (ft)	Length of Interval (ft)	Ambient Flow (gpm)	Ambient Specific Discharge (ft/day)	Interval Specific Flow Rate (gpm)	Delta Flow (gpm)	Interval Specific Flowrate (ft3/day)	Interval Specific Hydraulic Conductivity (ft/day)	Transmissivity (ft2/day)	Fluid Electrical Conductivity (microS/cm)
1	75.0	79.1	4.1	0.000	0.0000	0.205	0.205	39.465	1.66E+00	6.81E+00	11970
2	84.2	86.0	1.8	0.000	0.0000	0.265	0.265	51.016	4.89E+00	8.81E+00	11890
3	99.4	99.7	0.3	0.0007	0.0028	0.142	0.1413	27.202	1.57E+01	4.70E+00	11410
4	110.3	111.3	1.0	0.000	0.0000	0.138	0.138	26.567	4.59E+00	4.59E+00	11410
5	128.7	130.7	2.0	0.000	0.0000	0.087	0.087	16.749	1.45E+00	2.89E+00	7989
6	138.2	138.4	0.2	0.000	0.0000	0.087	0.087	16.749	1.45E+01	2.89E+00	9130
7	140.0	142.1	2.1	0.001	0.0006	0.087	0.086	16.556	1.36E+00	2.86E+00	9338
8	143.7	146.4	2.7	0.0005	0.0002	0.087	0.0865	16.652	1.06E+00	2.88E+00	9130
9	153.1	157.2	4.1	0.003	0.0009	0.167	0.164	31.572	1.33E+00	5.45E+00	15230

Notes:

All depths are referenced to ground surface.

All Ambient Flow was observed to be horizontal.

Ambient Specific Discharge is corrected for borehole convergence using convergence factor (alpha) = 2.5

gpm = gallons per minute.

Interval Specific Flow Rate is the rate of flow into the wellbore under stressed conditions (during production testing)

Delta Flow is the difference in flow between the Interval Specific Flow Rate and the Ambient Flow Rate.

ft^3/day = cubic feet per day.

ft/day = feet per day.

cm/s = centimeters per second.

ft^2/day = square feet per day.

cm^2/s = square centimeters per second.

Transmissivity (T) = Hydraulic Conductivity (K) * Length of Interval (b)

5.0 HYDROPHYSICAL™ LOGGING RESULTS - WELL GW-62BR

5.1 Ambient Fluid Electrical Conductivity and Temperature Log: GW-62BR

On April 28, 2000, after a calibration check of the fluid electrical conductivity (FEC) and temperature logging tool, the fluid column was logged for FEC and temperature profiles with COLOG's 1.5-inch diameter HpL™ tool. These logs were performed prior to the installation of any pumping equipment. Please refer to Figure GW-62BR:1. The ambient FEC/T profiles indicate a change in FEC and temperature at a depth of 75.5 to 79.2, 90.2, and 94.4 to 98.7 feet, suggesting a dynamic, or flowing, condition in the borehole at these depths. In vertically flowing conditions, where water enters the borehole, termed inflow, a change in either FEC and/or temperature is typically seen.

5.2 Ambient Flow Characterization: GW-62BR

On April 28, 2000, ambient flow characterization was conducted in GW-62BR. For ambient flow assessment, the formation water in the wellbore was diluted with deionized water (DI) and the well left in an undisturbed state to allow any natural flow to occur. The pump was removed from the well to insure that water in the pump standpipe would not drain back into the well. Prior to this period and throughout all HpL™ testing, water levels were monitored and recorded. Ambient flow evaluation is reported for the period after the water surface returned to near pre-emplacement levels. A series of FEC and temperature logs were then conducted to identify changes in the fluid column associated with ambient flow. In addition to vertical flow characterization, the presence of horizontal flow was evaluated.

On April 28, 2000, at 1546 hours (T=0.00 minutes, elapsed time of test), dilution of the fluid column was complete. Minimal to no DI water was lost to the formation due to the slightly depressed head during emplacement procedures. During the 1.67 hours following dilution, multiple logs were conducted. Of these logs, nine are presented in Figure GW-62BR:2 with the first log occurring during dilution. Only logs acquired during logging in the downward direction are presented as the design of the FEC/T probe allows for the most accurate data to be collected in the downward direction. The logs acquired in the upward logging direction are not representative of downhole conditions and are therefore omitted. These logs illustrate significant change over the length of the borehole, most notably from 75.5 to 79.2 feet. These changes in the FEC profiles with respect to time are associated with ambient vertical flow occurring within this interval.

A tessellated[1] chromographic summary of all downward FEC traces is presented in Figure GW-62BR:3. FEC of 0 μS/cm is represented on this figure by the dark blue color, with a spectral color progression to red as the values increase linearly to 650 μS/cm.

Formation water migration caused by vertical flow within the fluid column is indicated by the chromatically defined lineaments in Figure GW-62BR:3 for the interval of 75 (bottom of casing) to 79.2 feet, 90.2 to 93.0 feet, and 98.1 to 98.7 feet. Direct interpretation of the data for this interval suggests that inflow (flow from the localized aquifers *into* the well) is occurring in the interval 75.5 to 79.2 feet at 0.075 gpm. This inflow then migrates downward at 0.199 feet/min where, at 90.2 to 93.0 feet the velocity decreases to 0.059 feet/min indicating 0.053 gpm exited the borehole. 0.022 gpm continues to migrate downward where, at 98.1 to 98.7 the aggregate flow exits the borehole. Evidence for this downward migration and outflow is apparent in both the Ambient Flow Characterization (AFC) logs in Figure GW-62BR:2 and the Ambient FEC/T logs in Figure GW-62BR:1, and the change in slope of the chromatically defined lineaments in Figure GW-62BR:3 at these depths. The depth to water at the time of ambient flow testing was 2.83 feet below top of casing (fbtoc).

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[1] Referring specifically to the mosaic coloration of FEC values between traces.

5.3 Flow Characterization During 0.8 GPM Production Test: GW-62BR

Pumping of wellbore fluids after emplacement of DI water was conducted at one pumping rate to establish the inflow locations and evaluate the interval specific inflow rates and FEC. Pumping at a given rate was conducted after dilution until numerous FEC/Temperature logs were acquired and the well characterized. These procedures were conducted at a pumping rate of 0.76 gpm. Wellbore storage contributed 0.59 gpm to the overall pumping rate, making the formation production rate during testing 0.17 gpm.

On April 28, 2000, at 1808 hours (T = 0.0 minutes elapsed time of testing), pumping was initiated at about 0.8 gpm. Prior to initiating pumping, the depth to water was recorded at 2.83 fbtoc. All drawdown values are referenced to this ambient water level. Time dependent depth to water, totals and flow rate information were recorded and are presented in Figure GW-62BR:4. Pumping was maintained at a time-averaged rate of 0.76 gpm until 1900 hours (T = 52 minutes, elapsed time of testing). During pumping, drawdown did not stabilize. Wellbore storage contributed a constant 0.59 gpm to the overall production rate of 0.76 gpm. During pumping, nine FEC logs were acquired and are presented in Figure GW-62BR:5. The logs show inflow entering the borehole at each of the marked increases in FEC. The water entering the borehole is observed to be moving upwards toward the pump inside casing. The nomenclature for the logs is a series of time tags. The last four digits of each log ID corresponds to the time at which that particular log was started. Seven inflow zones are identified from these logs with flow rates ranging from 0.0005 to 0.121 gpm. The logs indicate the majority of inflow coming from near the base of casing at 755 to 79.2 feet. Please refer to Table GW-62BR:1 for a summary of flow results and the depths of individual inflow zones.

5.4 Estimation of Interval Specific Hydraulic Conductivity: GW-62BR

An estimation of horizontal hydraulic conductivity (K) can be made using an equation after Hvorslev (1951) assuming steady-state radial flow in an unconfined aquifer:

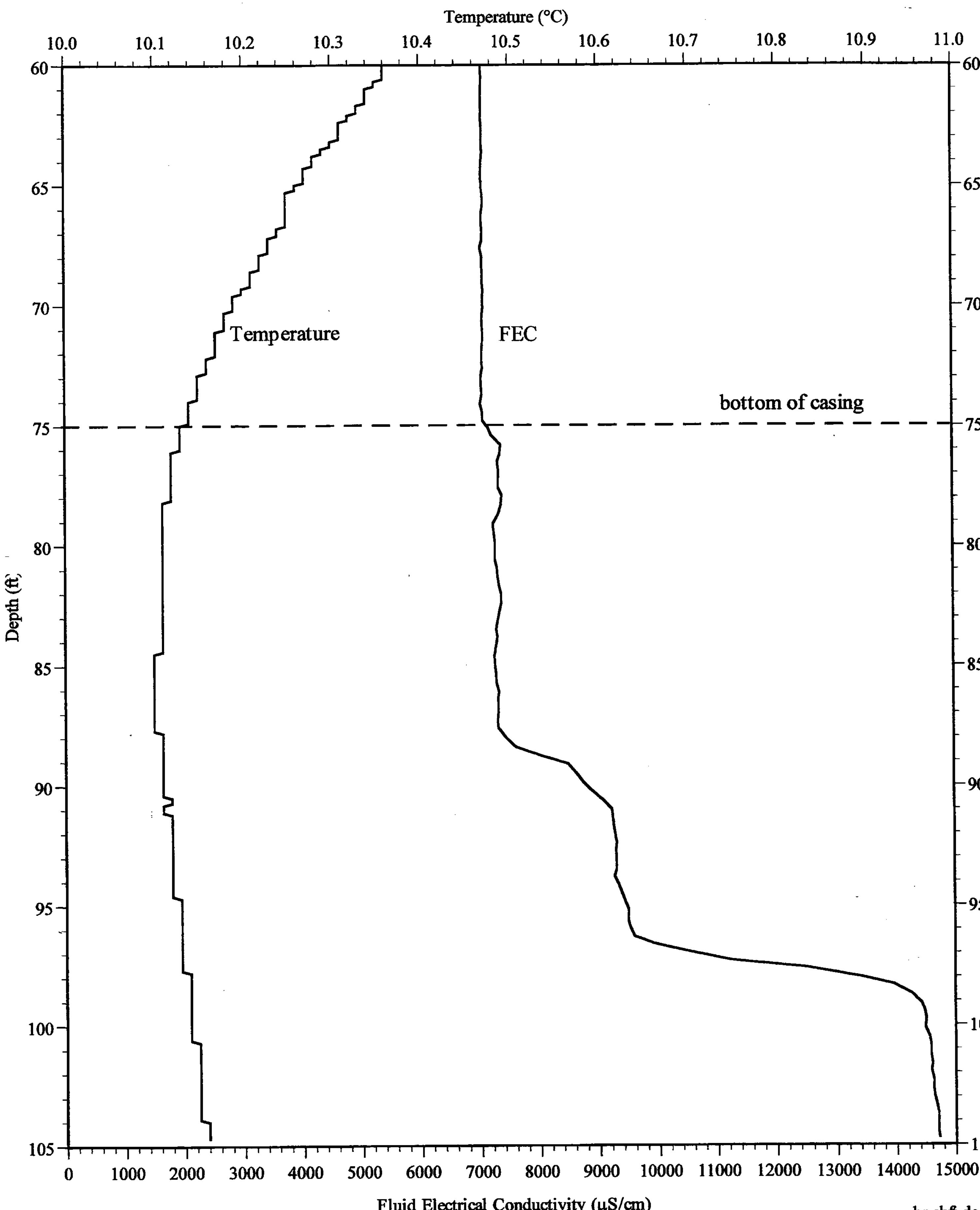
$$T = KL = \frac{q_i}{2\pi\Delta h_w}\ln\left(\frac{r_e}{r_w}\right)$$

where K is the hydraulic conductivity, q_i is the interval specific inflow rate calculated by HpL™ results, r_w is the borehole radius (0.13 ft), r_e is the effective pumping radius , Δh_w is the observed maximum drawdown and L is the thickness of the zone through which flow occurs. For our calculations, COLOG used r_e of 200 feet (assumed). By applying L and q_i from the HpL™ results under the two pressure conditions, the interval specific hydraulic conductivity can be calculated for each identified water producing interval. These calculations were made at each identified interval and are presented in Table GW-62BR:1.

5.5 Data Interpretation: GW-62BR

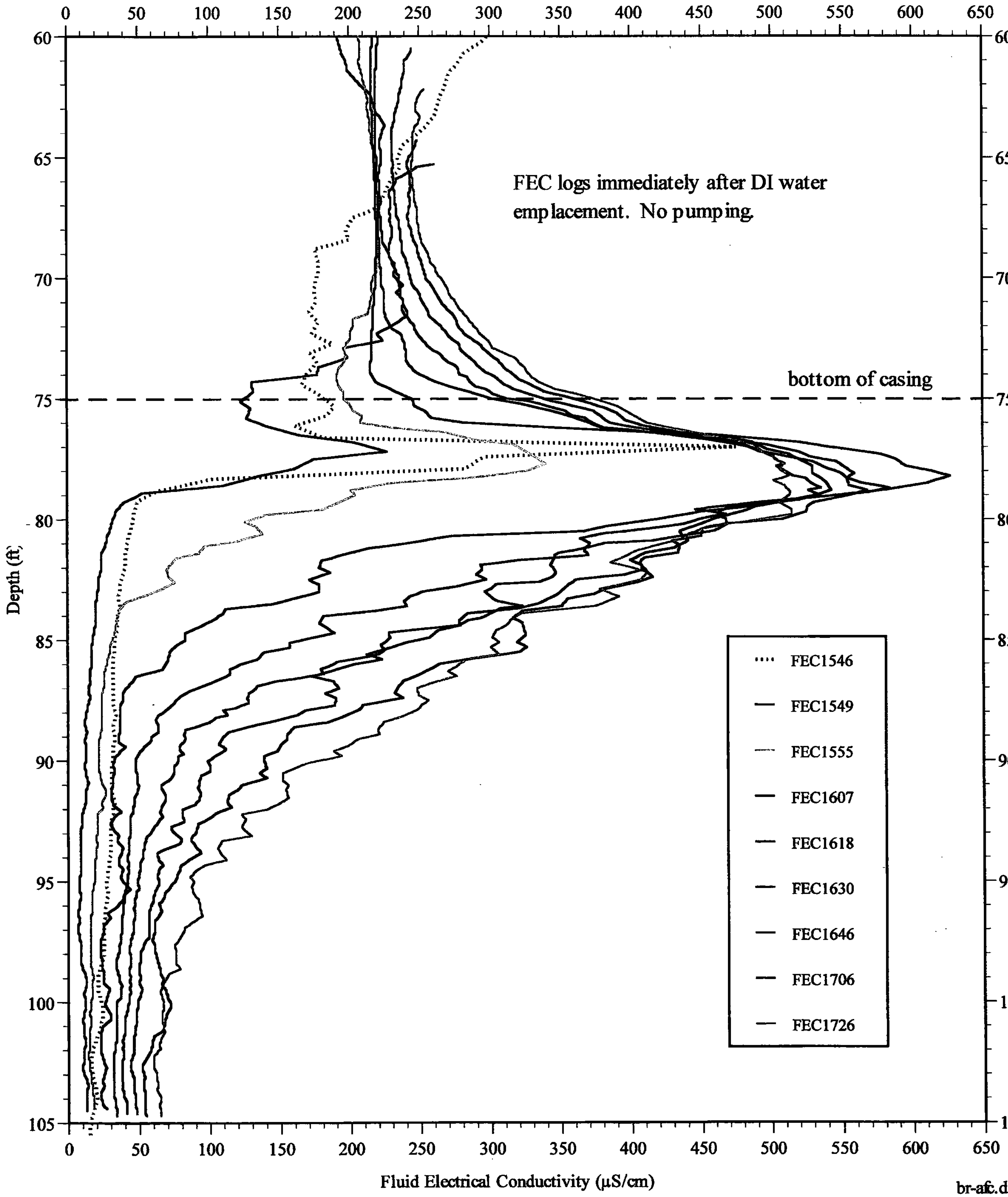
Processing and interpretation of the HydroPhysical™ logs obtained during pumping (Figure GW-62BR:5) suggest the presence of 7 producing intervals for this wellbore. Numerical modeling of the reported field data was performed using the computer program BORE. Analyses were performed to estimate the rate of inflow for each identified hydraulically conductive wellbore interval during pumping. The results of these analyses are presented Table GW-62BR:1. In summary, the interval 75.5 to 79.2 feet dominated inflow during the production test at 0.76 gpm. This interval contributed 0.121 gpm or 71.2 percent of the total formation flow rate during the production test. The remaining 6 intervals contributed the remaining 0.049 gpm (28.8%). During ambient testing, well GW-62BR exhibited a relatively simple ambient flow scenario. The majority of inflow during ambient testing originated from the base of casing at 75.5 to 79.2 feet. A downward vertical gradient was observed within the wellbore. Formation waters migrated downward in the wellbore at velocities of 0.199 fpm above 88.2 feet and 0.059 fpm at the lowermost portions of the borehole. Two exit intervals thieving water were directly observed at 90.2 to 93.0 and 98.1 to 98.7 feet, thieving water from the borehole at 0.053 and 0.022 gpm, respectively. Interval-specific transmissivities in GW-62BR ranged from 0.013 to 0.436 feet^2/day, with the interval of 90.2 to 93.0 feet registering the highest transmissivity. Aside from the highest T value, the remaining seven interval-specific transmissivity estimates did not differ significantly with respect to each other. Interval-specific FEC ranged from 14,960 to 15,160 µS/cm, however, the majority of the inflow zones exhibited a uniform 14,960 µS/cm FEC. Similar FEC is indicative of a communicating fracture network, however, the presence of a pressure differential within the borehole contradicts this. The fact that during ambient testing a much lower FEC was observed coming from the upper intervals (see Figure GW-62BR:1) suggests during ambient testing there is less communication between aquifers. Only when a stress is put on the aquifer system do to fracture networks communicate, evidenced in the similar FEC values during pumping. Please see Table GW-62BR:1 for a summary which includes the locations and rates of inflow and transmissivity estimates assessed by COLOG.

FIGURE GW-62BR:1. AMBIENT TEMPERATURE AND FLUID ELECTRICAL CONDUCTIVITY; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BR



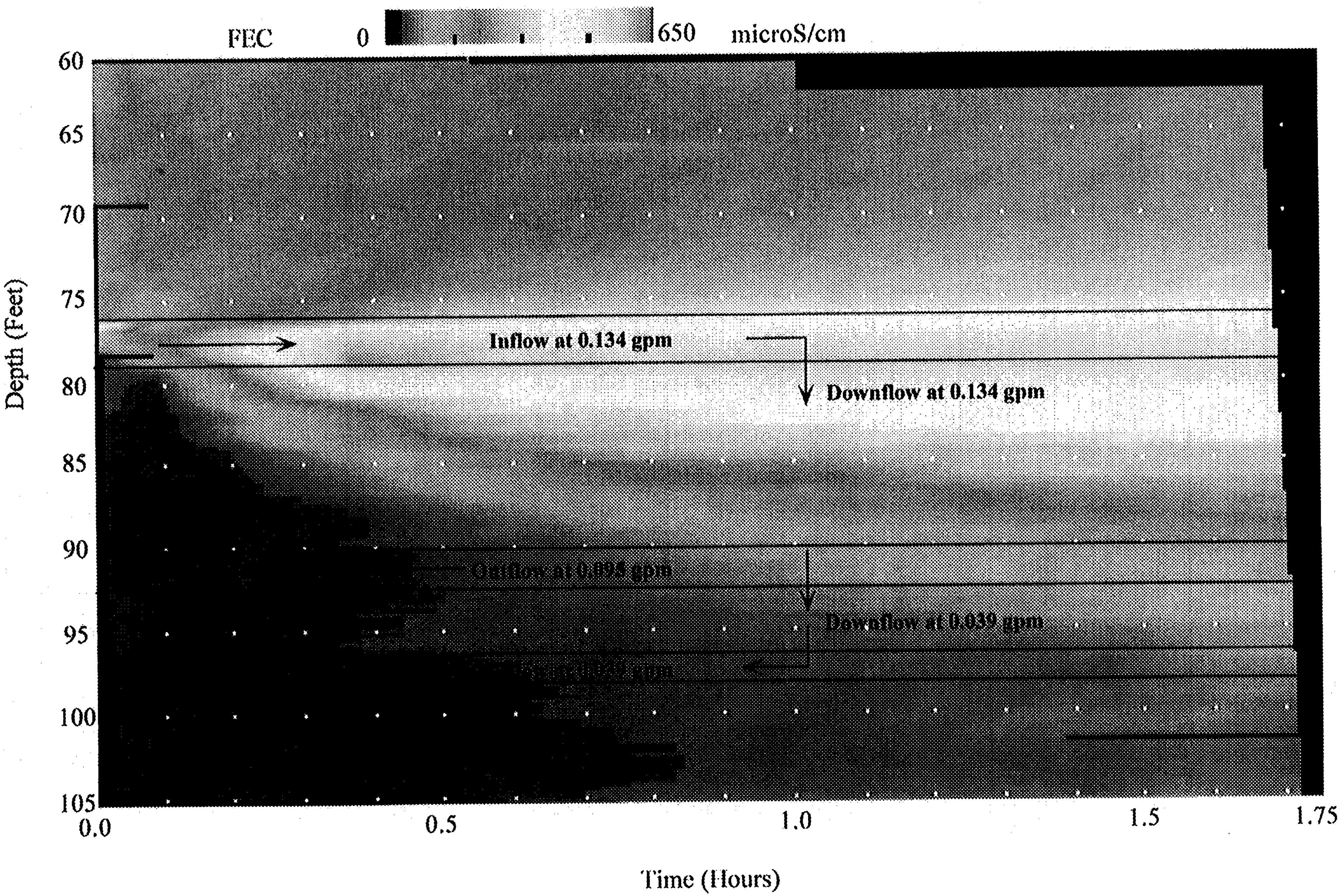
br-abf.dg4

FIGURE GW-62BR:2. SUMMARY OF HYDROPHYSICAL LOGS DURING AMBIENT FLOW CHARACTERIZATION; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BR



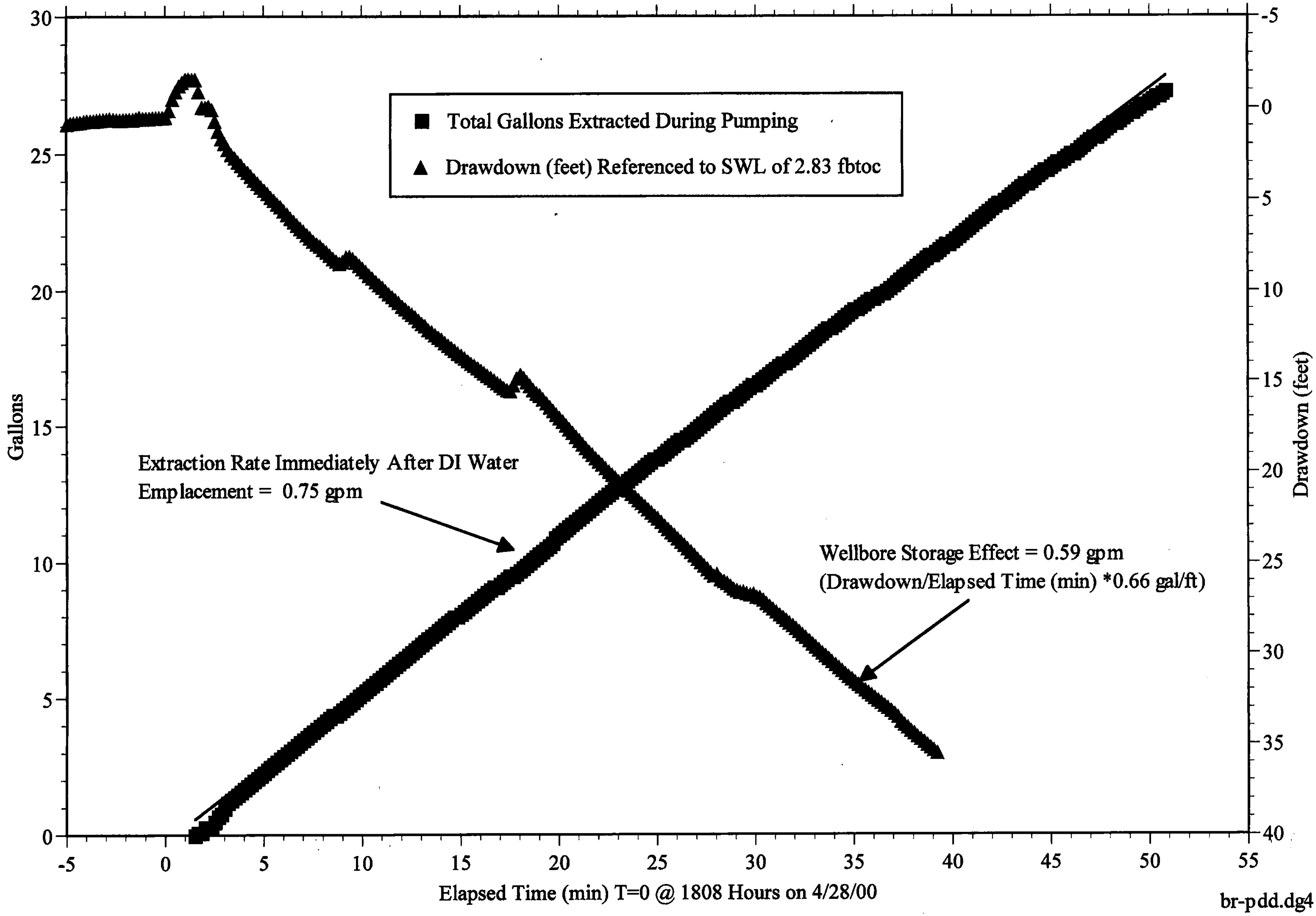
br-afc.dg4

FIGURE GW-62BR:3. CHROMOGRAPHIC TESSELLATION OF FEC LOGS DURING AMBIENT FLOW CHARACTERIZATION; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BR



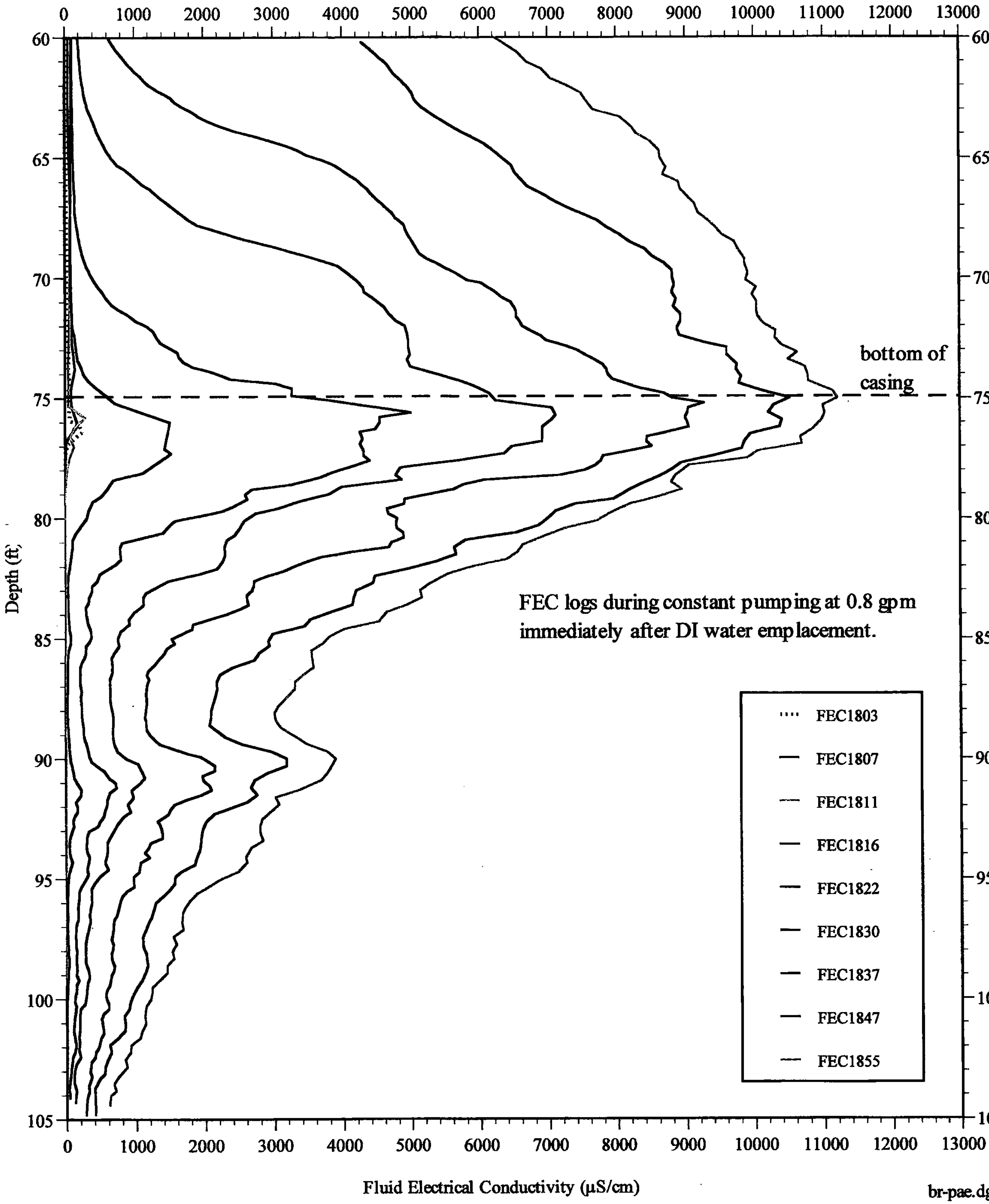
62br-afc.cvs

FIGURE GW-62BR:4. PUMPING AND DRAWDOWN DATA FOR 0.8 GPM TEST; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BR



br-pdd.dg4

FIGURE GW-62BR:5. SUMMARY OF HYDROPHYSICAL LOGS DURING LOW RATE PUMPING AT 0.8 GPM AFTER DI WATER EMPLACEMENT; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BR



br-pae.dg4

TABLE GW-62BR:1. SUMMARY OF HYDROPHYSICAL™ LOGGING RESULTS WITH HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY ESTIMATIONS; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BR

Project and Well name	Olin, Wilmington Project, Well: GW-62BR
Ambient Depth to water (fbtoc)	2.83
Diameter of Borehole (ft)	0.25
Maximum Drawdown (ft)	35.80
Effective Radius (ft)	200
Formation Production Rate (gpm	0.17

Well GW-62BR Interval No.	Top of Interval (ft)	Bottom of Interval (ft)	Length of Interval (ft)	Ambient Flow (gpm)	Ambient Specific Discharge (ft/day)	Interval Specific Flow Rate (gpm)	Delta Flow (gpm)	Interval Specific Flowrate (ft3/day)	Interval Specific Hydraulic Conductivity (ft/day)	Transmissivity (ft2/day)	Fluid Electrical Conductivity (microS/cm)
1	75.5	79.2	3.7	0.075	NA	0.121	0.046	8.856	7.85E-02	2.91E-01	14960
2	80.9	81.2	0.3	0.000	NA	0.013	0.013	2.503	2.74E-01	8.21E-02	14960
3	83.5	83.7	0.2	0.000	NA	0.009	0.009	1.733	2.84E-01	5.69E-02	14960
4	85.0	85.3	0.3	0.000	NA	0.008	0.008	1.540	1.68E-01	5.05E-02	14960
5	90.2	93.0	2.8	-0.053	NA	0.016	0.069	13.283	1.56E-01	4.36E-01	15010
6	94.4	94.8	0.4	0.000	NA	0.002	0.002	0.385	3.16E-02	1.26E-02	15010
7	98.1	98.7	0.6	-0.022	NA	0.0005	0.0225	4.332	2.37E-01	1.42E-01	15160

Notes:

All depths are referenced to ground surface.

All Ambient Flow was observed to be vertically downward. A negative ambient flow value indicates outflow.

Ambient Specific Discharge (horizontal flow only) is corrected for borehole convergence using convergence factor (alpha) = 2.5

NA = Not Applicable

gpm = gallons per minute.

Interval Specific Flow Rate is the rate of flow into the wellbore under stressed conditions (during production testing)

Delta Flow is the difference in flow between the Interval Specific Flow Rate and the Ambient Flow Rate.

ft^3/day = cubic feet per day.

ft/day = feet per day.

cm/s = centimeters per second.

ft^2/day = square feet per day.

cm^2/s = square centimeters per second.

Transmissivity (T) = Hydraulic Conductivity (K) * Length of Interval (b)

6.0 HYDROPHYSICAL™ LOGGING RESULTS - WELL GW-62BRD

6.1 Ambient Fluid Electrical Conductivity and Temperature Log: GW-62BRD

At 1015 hours on April 29, 2000, after a calibration check of the fluid electrical conductivity (FEC) and temperature logging tool, the fluid column was logged for FEC and temperature profiles with COLOG's 1.5-inch diameter HpL™ tool. These logs were performed prior to the installation of any pumping equipment. Please refer to Figure GW-62BRD:1. The ambient FEC/T profiles indicate a change in FEC and temperature at a depth of 130.7 to 130.9, 140.6 to 140.9 and 141.9 to 142.3 feet, suggesting a dynamic, or flowing, condition in the borehole at these depths. In vertically flowing conditions, where water enters the borehole, termed inflow, a change in either FEC and/or temperature is typically seen.

6.2 Ambient Flow Characterization: GW-62BRD

On April 29, 2000, ambient flow characterization was conducted in GW-62BRD. For ambient flow assessment, the formation water in the wellbore was diluted with deionized water (DI) and the well left in an undisturbed state to allow any natural flow to occur. The pump was removed from the well to insure that water in the pump standpipe would not drain back into the well. Prior to this period and throughout all HpL™ testing, water levels were monitored and recorded. Ambient flow evaluation is reported for the period after the water surface returned to near pre-emplacement levels. A series of FEC and temperature logs were then conducted to identify changes in the fluid column associated with ambient flow. In addition to vertical flow characterization, the presence of horizontal flow was evaluated.

On April 29, 2000, at 1122 hours (T=0.00 minutes, elapsed time of test), dilution of the fluid column was complete. Minimal to no DI water was lost to the formation due to the slightly depressed head during emplacement procedures. During the 2.03 hours following dilution, multiple logs were conducted. Of these logs, five are presented in Figure GW-62BRD:2, with the first log occurring during emplacement. Only logs acquired during logging in the downward direction are presented as the design of the FEC/T probe allows for the most accurate data to be collected in the downward direction. The logs acquired in the upward logging direction are not representative of downhole conditions and are therefore omitted. These logs illustrate little change over the length of the borehole, indicating little to no ambient flow in the wellbore. Several intervals showed minor change in FEC over the duration of the test. These changes in the FEC profiles with respect to time are associated with ambient flow occurring within these intervals.

A tessellated[1] chromographic summary of all downward FEC traces is presented in Figure GW-62BRD:3. FEC of 0 μS/cm is represented on this figure by the dark blue color, with a spectral color progression to red as the values increase linearly to 80 μS/cm.

Formation water migration caused by vertical flow within the fluid column is indicated by the chromatically defined lineaments in Figure GW-62BRD:3 for the interval of 105 (bottom of casing) to 130.9 feet, 140.6 to 140.9 and 141.9 to 142.3 feet. Direct interpretation of the data for these intervals suggests that inflow (flow from the localized aquifers *into* the well) is occurring in various intervals within the 105 to 130.9 feet at very low flow rates ranging from 0.0001 to 0.0003 gpm. This inflow appears to migrate downward and exit the borehole at 140.6 to 140.9 feet. This downward migration, however, is contradictory to staining observed in the borehole from the BIPS digital video of GW-62BRD which indicates flow migrating upward in some intervals. This contradiction may be a result of the extremely low flow rates observed in the borehole during ambient flow testing. Evidence for this downward migration and outflow is apparent in both the Ambient Flow Characterization (AFC) logs in Figure GW-62BRD:2 and the Ambient FEC/T logs in Figure GW-62BRD:1, and the change in slope of the chromatically defined lineaments in Figure GW-62BRD:3 at that depth. Horizontal flow is observed at 141.0 to 142.3 feet at a

[1] Referring specifically to the mosaic coloration of FEC values between traces.

velocity of 0.015 feet/day within the borehole. Correcting for convergence to a wellbore (*Drost, 1968*), this equates to a specific discharge of the aquifer of 0.006 feet/day. The depth to water at the time of ambient flow testing was 2.64 feet below top of casing (fbtoc).

6.3 Flow Characterization During 8 GPM Production Test: GW-62BRD

Pumping of wellbore fluids after emplacement of DI water was conducted at one pumping rate to establish the inflow locations and evaluate the interval specific inflow rates and FEC. Pumping at a given rate was conducted after dilution until numerous FEC/Temperature logs were acquired and the well characterized. These procedures were conducted at a pumping rate of 0.86 gpm. Wellbore storage contributed 0.069 gpm to the overall pumping rate, making the formation production rate during testing 0.79 gpm.

On April 29, 2000, at 1450 hours (T = 0.0 minutes elapsed time of testing), pumping was initiated at about 0.9 gpm. Prior to initiating pumping, the depth to water was recorded at 2.64 fbtoc. All drawdown values are referenced to this ambient water level. Time dependent depth to water, totals and flow rate information were recorded and are presented in Figure GW-62BRD:4. Pumping was maintained at a time-averaged rate of 0.86 gpm until 1637 hours (T = 107 minutes, elapsed time of testing). During pumping, a reasonably constant drawdown of about 51.75 feet was observed. COLOG defines reasonably constant drawdown as drawdown that fluctuates less than 10 percent of the total drawdown. During pumping, ten FEC logs were acquired and are presented in Figure GW-62BRD:5 with the first log acquired during dilution of the borehole. The logs show inflow entering the borehole at each of the marked increases in FEC. The water entering the borehole is observed to be moving upwards toward the pump inside casing. The nomenclature for the logs is a series of time tags. The last four digits of each log ID corresponds to the time at which that particular log was started. Nine inflow zones are identified from these logs with flow rates ranging from 0.033 to 0.211 gpm. The logs indicate the majority of inflow coming from the bottom of the borehole at 141.9 to 142.3 feet. Please refer to Table GW-62BRD:1 for a summary of flow results and the depths of individual inflow zones.

6.4 Estimation of Interval Specific Hydraulic Conductivity: GW-62BRD

An estimation of horizontal hydraulic conductivity (K) can be made using an equation after Hvorslev (1951) assuming steady-state radial flow in an unconfined aquifer:

$$T = KL = \frac{q_i}{2\pi \Delta h_w} \ln\left(\frac{r_e}{r_w}\right)$$

where K is the hydraulic conductivity, q_i is the interval specific inflow rate calculated by HpL™ results, r_w is the borehole radius (0.17 ft), r_e is the effective pumping radius , Δh_w is the observed maximum drawdown (51.75 feet) and L is the thickness of the zone through which flow occurs. For our calculations, COLOG used r_e of 200 feet (assumed). By applying L and q_i from the HpL™ results under the two pressure conditions, the interval specific hydraulic conductivity can be calculated for each identified water producing interval. These calculations were made at each identified interval and are presented in Table GW-62BRD:1.

6.5 Data Interpretation: GW-62BRD

Processing and interpretation of the HydroPhysical™ logs obtained during pumping (Figure GW-62BRD:5) suggest the presence of 9 producing intervals for this wellbore. Numerical modeling of the reported field data was performed using the computer program BORE. Analyses were performed to estimate the rate of inflow for each identified hydraulically conductive wellbore interval during pumping.

The results of these analyses are presented Table GW-62BRD:1. In summary, the interval 141.9 to 142.3 feet dominated inflow during the production test at 0.79 gpm. This interval contributed 0.211 gpm or 26.7 percent of the total flow during the production test. One other interval showed moderate inflow at 138.8 to 135.5 feet, producing 0.169 gpm or 21.4 percent of the total inflow. The remaining 7 inflow intervals contributed the remaining 0.41 gpm (51.9%). During ambient testing, well GW-62BRD exhibited very low ambient flow primarily in the downward direction. The volume of flow is so low that flow direction was difficult to ascertain except for interval 141.9 to 142.3 feet, which is clearly horizontal flow. As stated in section 6.2 of this report, the BIPS digital camera recorded staining in the borehole which may suggest flow direction at that depth. In several cases, the flow direction suggested by the staining was upward. There is no evidence in the logs (Figure GW-62BRD:2) to suggest upward ambient flow. Either that staining occurred immediately after drilling as water level rose, or the well exhibited a different ambient flow scenario as that during testing. Interval-specific transmissivities in GW-62BRD ranged from 0.010 to 0.878 square feet per day with the interval of 141.9 to 142.3 feet registering the highest transmissivity. Interval-specific transmissivity estimates did not differ significantly with respect to each other. Interval-specific FEC did, however, rang significantly within the borehole. FEC ranged from 1,940 to 9,549 μS/cm, with the dominant flow intervals containing the highest FEC. The lack of a significant pressure differential within a borehole and similar T values are suggestive of an inter-connected fracture network or aquifers within the region of the wellbore. However, the FEC differential observed does not support a highly connected fracture network. Specific water chemistry may explain the difference in FEC as some aqueous-phase constituents will gather at depths according to specific gravity, density, etc. Please see Table GW-62BRD:1 for a summary which includes the locations and rates of inflow and transmissivity estimates assessed by COLOG.

FIGURE GW-62BRD:1. AMBIENT TEMPERATURE AND FLUID ELECTRICAL CONDUCTIVITY; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BRD

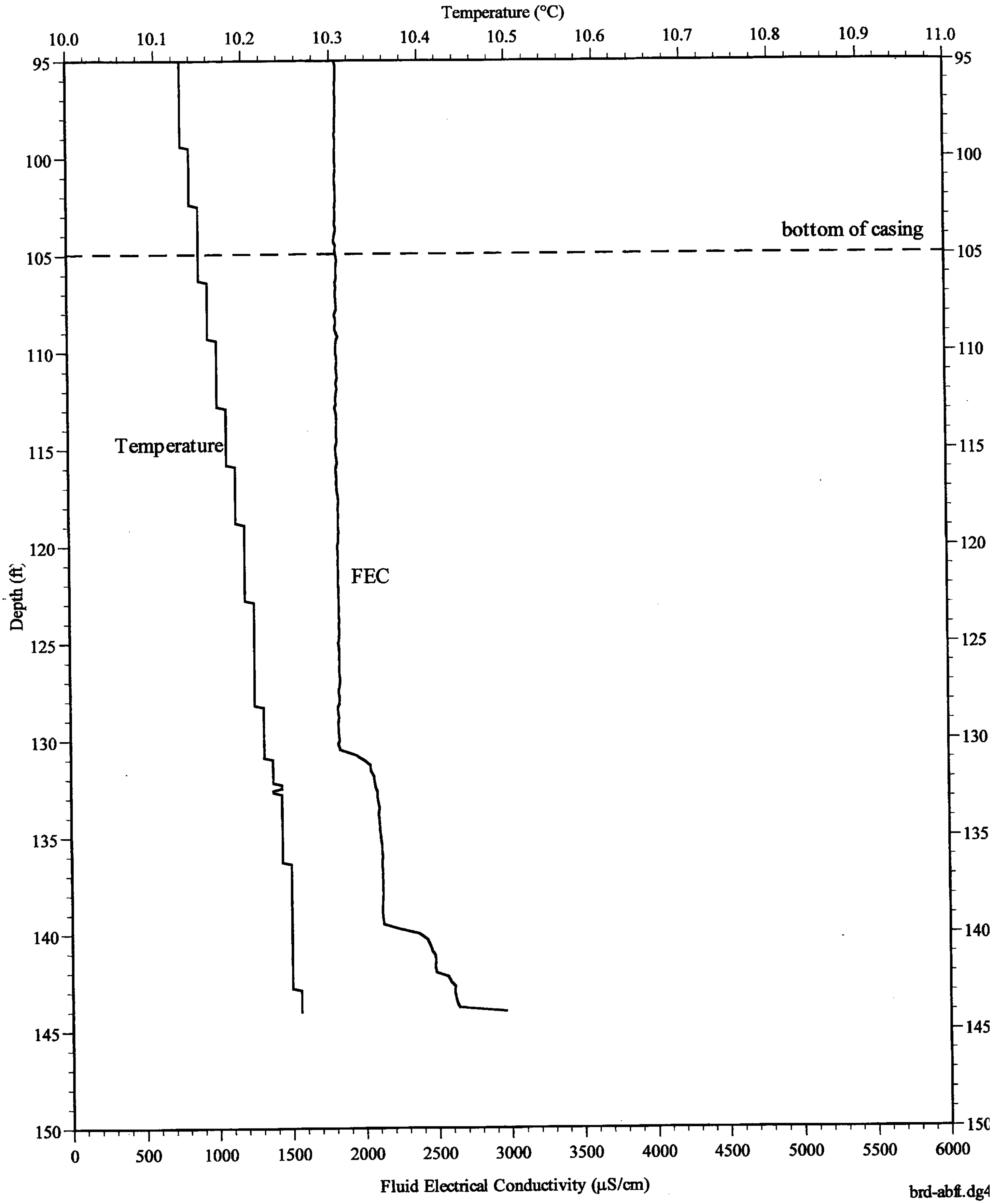
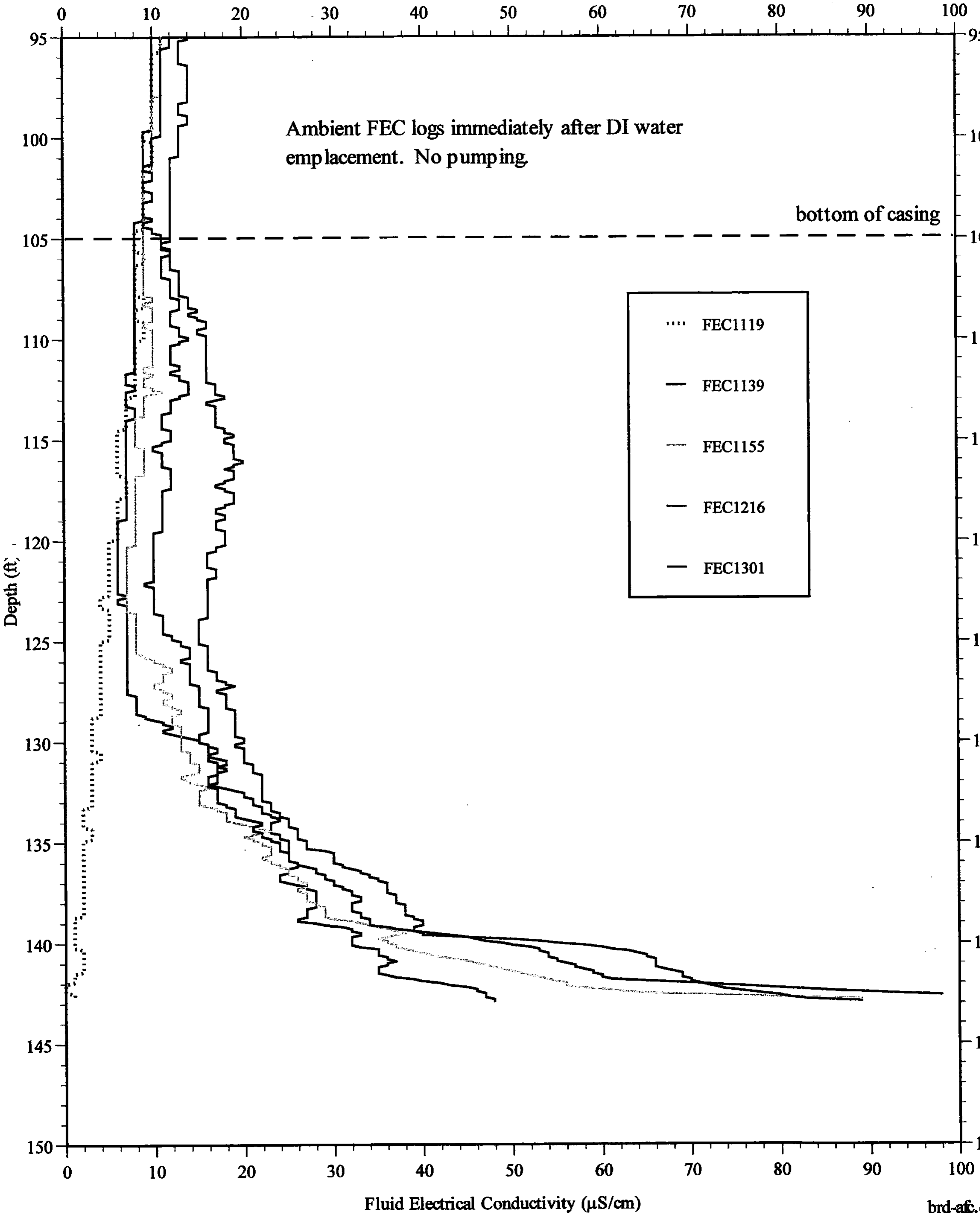
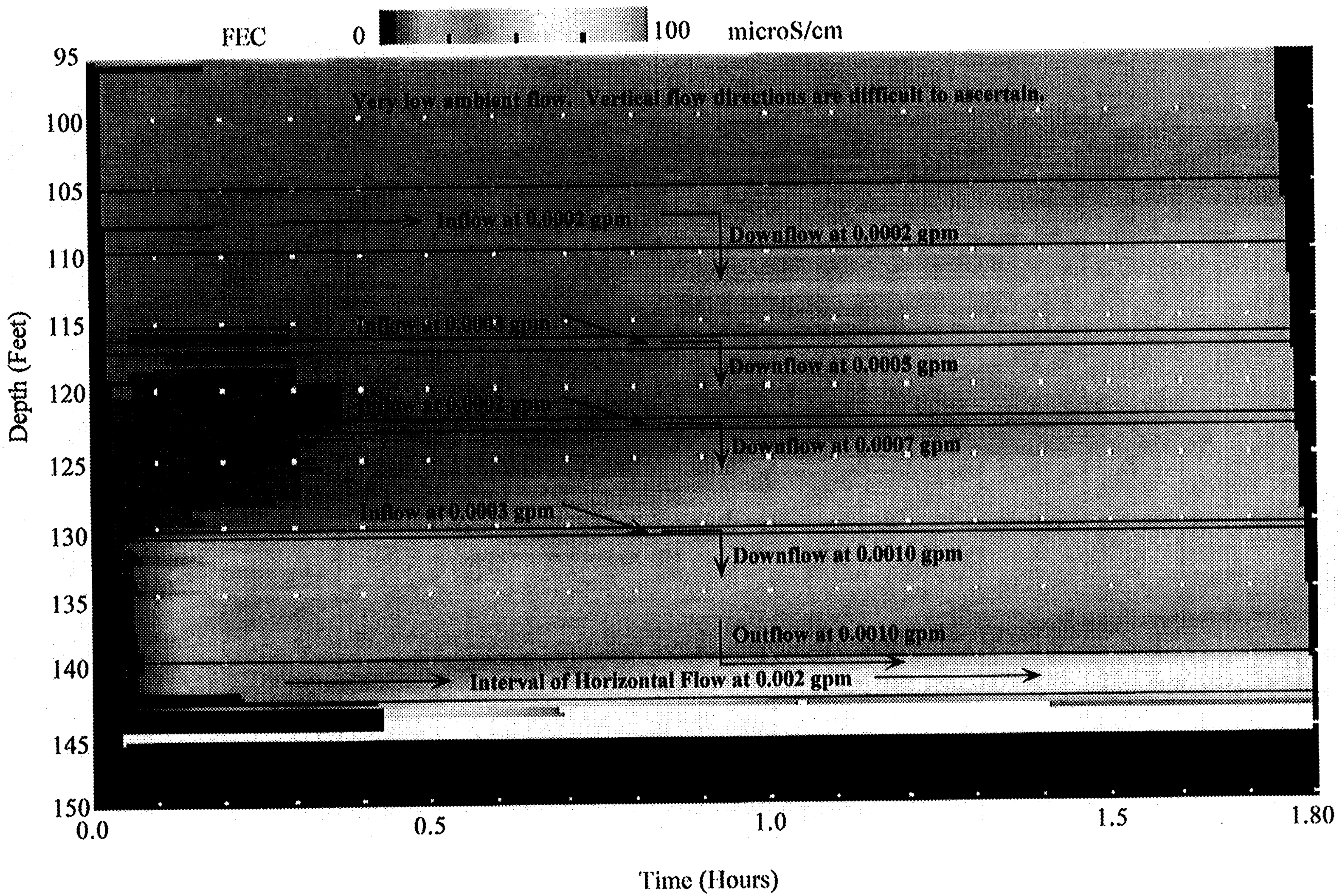


FIGURE GW-62BRD:2. SUMMARY OF HYDROPHYSICAL LOGS DURING AMBIENT FLOW CHARACTERIZATION; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BRD



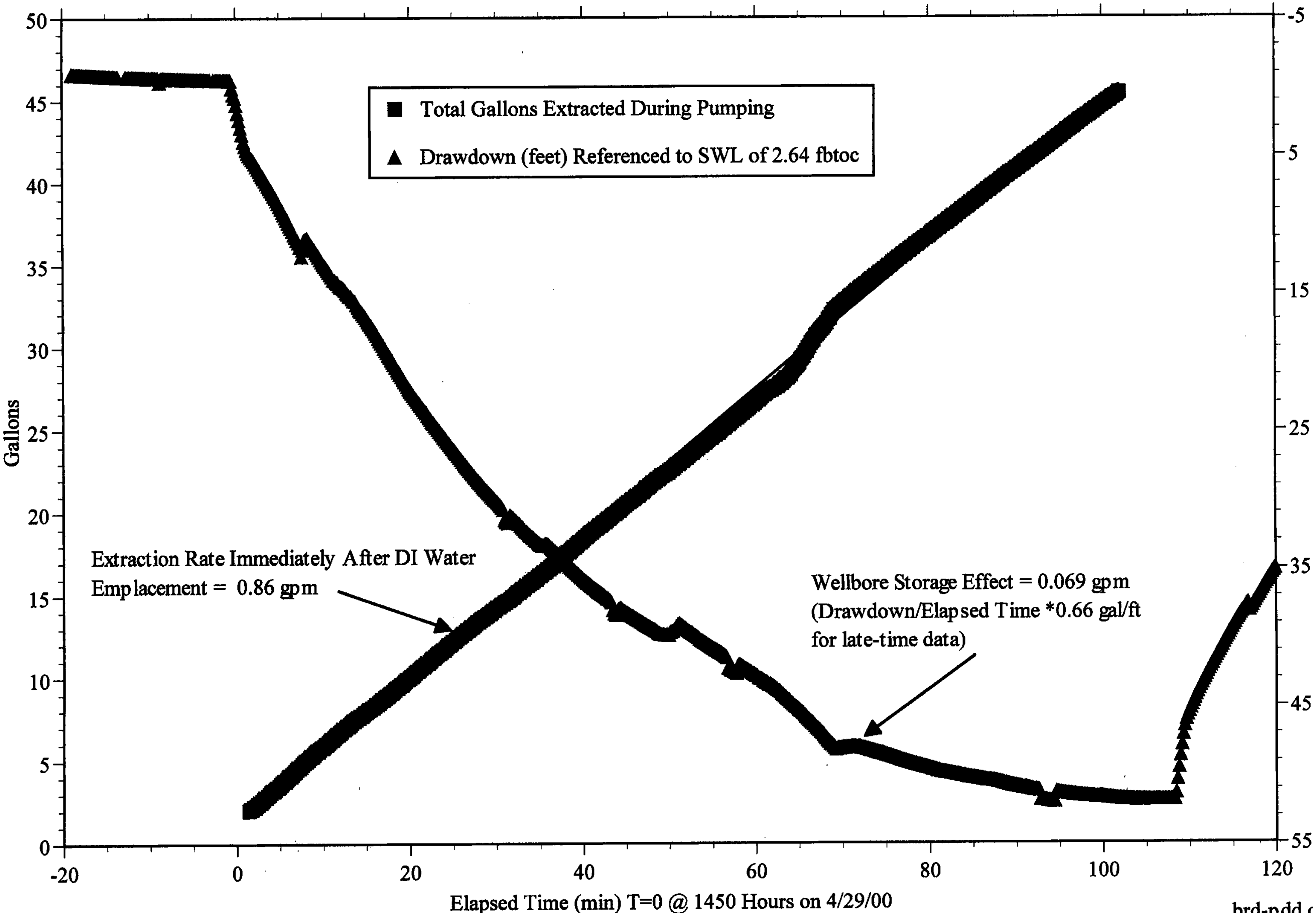
brd-afc.dg4

FIGURE GW-62BRD:3. CHROMOGRAPHIC TESSELLATION OF FEC LOGS DURING AMBIENT FLOW CHARACTERIZATION; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BRD



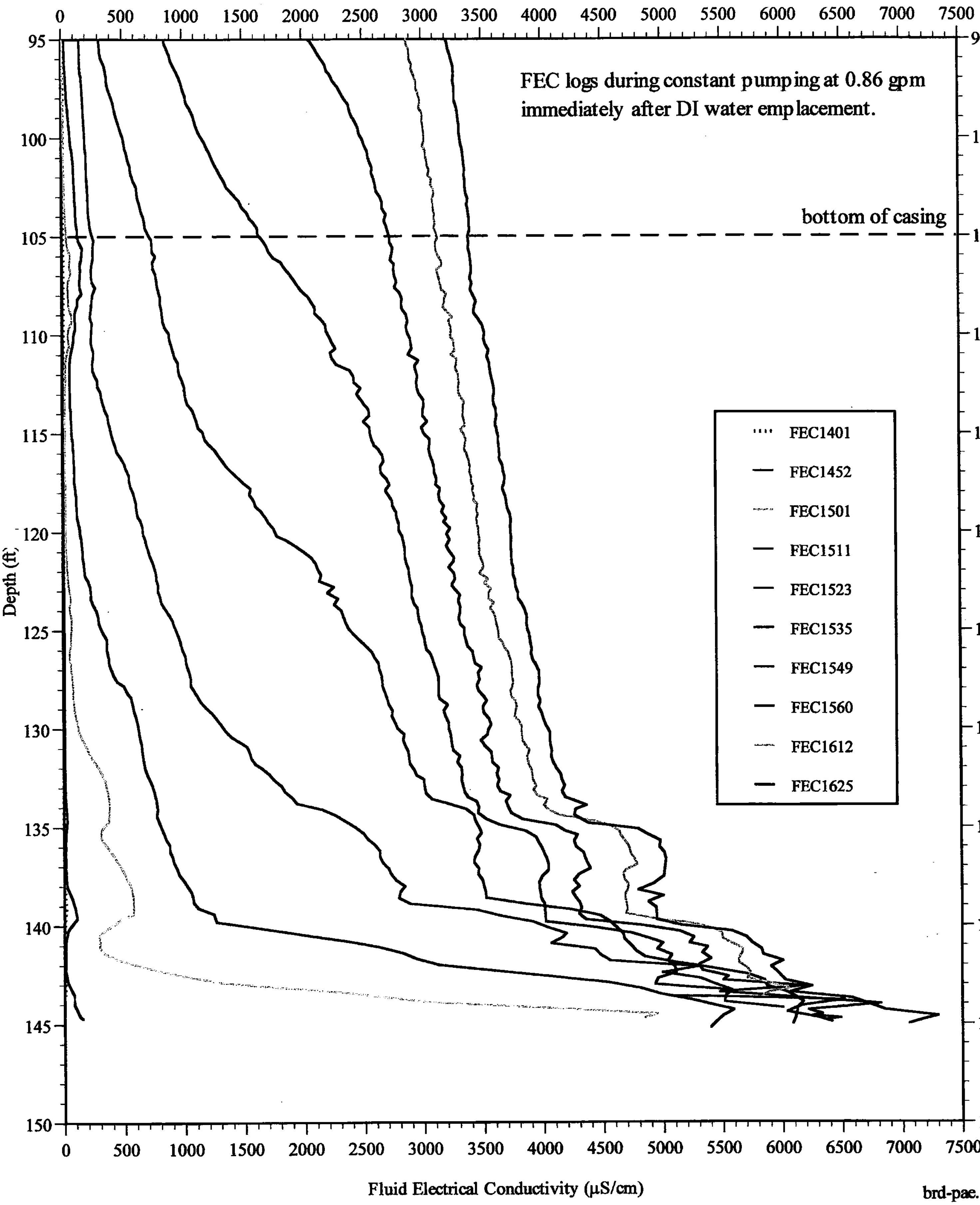
62brdafc.cvs

FIGURE GW-62BRD:4. PUMPING AND DRAWDOWN DATA FOR 0.9 GPM TEST; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BRD



brd-pdd.c

FIGURE GW-62BRD:5. SUMMARY OF HYDROPHYSICAL LOGS DURING LOW RATE PUMPING AT 0.5 GPM AFTER DI WATER EMPLACEMENT; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BRD



brd-pae.dg4

TABLE GW-62BRD:1. SUMMARY OF HYDROPHYSICAL™ LOGGING RESULTS WITH HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY ESTIMATIONS; GEOMEGA; OLIN, WILMINGTON PROJECT; WILMINGTON, MA; WELL GW-62BRD

Project and Well name	Olin, Wilmington Project, Well: GW-62BRD
Ambient Depth to water (fbtoc)	2.64
Diameter of Borehole (ft)	0.33
Maximum Drawdown (ft)	51.75
Effective Radius (ft)	200
Formation Production Rate (gpm	0.79

Well GW-62BRD Interval No.	Top of Interval (ft)	Bottom of Interval (ft)	Length of Interval (ft)	Ambient Flow (gpm)	Ambient Specific Discharge (ft/day)	Interval Specific Flow Rate (gpm)	Delta Flow (gpm)	Interval Specific Flowrate (ft3/day)	Interval Specific Hydraulic Conductivity (ft/day)	Transmissivity (ft2/day)	Fluid Electrical Conductivity (microS/cm)
1	105.0	110.3	5.3	0.0002	NA	0.066	0.0658	12.667	5.21E-02	2.76E-01	1940
2	117.5	117.8	0.3	0.0003	NA	0.051	0.0507	9.760	7.10E-01	2.13E-01	1940
3	122.4	123.4	1.0	0.0002	NA	0.033	0.0328	6.314	1.38E-01	1.38E-01	1940
4	125.8	126.0	0.2	0.0001	NA	0.043	0.0429	8.259	9.01E-01	1.80E-01	1940
5	128.8	129.9	1.1	0.0001	NA	0.101	0.1009	19.425	3.85E-01	4.24E-01	1940
6	130.7	130.9	0.2	0.0003	NA	0.024	0.0237	4.563	4.98E-01	9.96E-02	1940
7	134.8	135.5	0.7	0.0000	NA	0.169	0.169	32.535	1.01E+00	7.10E-01	2007
8	140.6	140.9	0.3	-0.0012	NA	0.094	0.0952	18.327	1.33E+00	4.00E-01	8334
9	141.9	142.3	0.4	0.0020	0.0060	0.211	0.209	40.235	2.19E+00	8.78E-01	9549

Notes:

All depths are referenced to ground surface.

All Ambient Flow was observed to be horizontal.

Ambient Specific Discharge is corrected for borehole convergence using convergence factor (alpha) = 2.5

gpm = gallons per minute.

Interval Specific Flow Rate is the rate of flow into the wellbore under stressed conditions (during production testing)

Delta Flow is the difference in flow between the Interval Specific Flow Rate and the Ambient Flow Rate.

ft^3/day = cubic feet per day.

ft/day = feet per day.

cm/s = centimeters per second.

ft^2/day = square feet per day.

cm^2/s = square centimeters per second.

Transmissivity (T) = Hydraulic Conductivity (K) * Length of Interval (b)

7.0 Conclusions

SB-8/MP-4

- Moderate ambient horizontal observed.
- Highest specific capacity of the three wells at 0.190 gpm/ft
- 9 producing intervals were identified during pumping at 1.24 gpm.
- Drawdown reached a constant 6.54 fbtoc.
- Transmissivity values ranged from 2.86 to 8.81 feet^2/day.
- Highest FEC of 15,230 µS/cm at 153.1 to 157.2 feet.

GW62-BR

- Strongest ambient flow of the three wells - downflow at 0.075 gpm.
- Lowest specific capacity of the three wells at 0.005 gpm/ft.
- 7 producing intervals were identified during pumping at 0.8 gpm.
- Drawdown reached a constant 35.80 feet but was not constant
- Transmissivity values range from 0.012 to 0.044 feet^2/day.
- Highest FEC of 15,160 µS/cm at 98.1 to 98.7 feet.

GW62-BRD

- Very low ambient downflow and horizontal flow observed.
- Moderate specific capacity of 0.015 gpm/ft.
- 9 producing intervals were identified during pumping at 0.86 gpm
- Transmissivity values range from 0.100 to 0.878 feet^2/day.
- Moderately high FEC observed at 141.9 to 142.3 feet of 9.549 µS/cm.

APPENDIX A

STANDARD OPERATING PROCEDURES FOR HYDROPHYSICAL™ LOGGING

COLOG DIVISION OF LAYNE CHRISTENSEN

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STANDARD OPERATING PROCEDURES
HYDROPHYSICAL™ LOGGING FOR AQUIFER CHARACTERIZATION

1. Purpose

Application of the HydroPhysical™ (HpL™) logging method to analyze and determine:

- The location of hydraulically conductive intervals within a wellbore
- The interval specific rate of inflow during well production, in conjunction with the drawdown data, can be used to estimate interval specific hydraulic conductivity or transmissivity
- Ambient (non-pumping) flow conditions (inflow and outflow rates, and locations)
- The hydrochemistry (fluid electrical conductivity (FEC) and temperature) of the associated formation waters

In addition, when downhole, discrete point fluid sampling is coupled with the HydroPhysical™ Logging technique, analysis of the actual contaminant concentrations associated with each identified conductive interval is accomplished for any aqueous phase contaminant.

2. Equipment and Materials

This SOP specifically applies to application of the technique using COLOG's HydroPhysical™ Logging Truck 16, which has been specially configured to handle those field conditions associated with small diameter, low-moderate yield wells The maximum capability of the van is to a total depth of 700 ft and 350 ft total drawdown (maximum depth to water) . In the event of high yield wells, the wireline capability of any COLOG truck can be used to accompany fluid management equipment.

- HydroPhysical™ logging truck field equipment includes:

- Fluid management system
  - Back Pressure Regulator or orifices
  - Rubber hose (0.75-inch i.d.) for injection
  - Submersible Pump
  - Evacuation Line
  - Storage tanks (as required) with inlet/outlet valves
  - Surface Pump
  - Fluid management manifold/Monitoring Panel
  - Data Acquisition System (for recording volumes, flow rates, time)
  - Wireline System
  - Wireline winch unit
  - Depth encoder
  - Water level indicator

- Computer System
  - HydroPhysical™ Logging tool
  - Downhole Fluid Sampler
- Deionizing Units
- Deionized water (prepared with wellbore fluids or transported on-site)
- Standard Reference Solutions - Electrical conductivity reference solutions (set of 3 solutions).

3. Procedures

1.) Review well construction details and complete general well information sheet. The HydroPhysical™ logging technique involves dilution of the wellbore fluids with DI water and profiling of the wellbore dynamics using a HydroPhysical™ logging tool. Significant aberrations or reductions in the borehole diameter should be identified as the downhole equipment can become lodged in the borehole. Additionally, application of the technique requires certain wellbore conditions:

- In open bedrock boreholes, casing must be installed through the overburden and grouted at the rock/alluvium interface to inhibit water leakage into the borehole from the saturated alluvium. For cased boreholes, the well should be fully cased and gravel packed with single or multiple screened intervals;
- The diameter of the borehole must be 4 inches or greater for application with the slim-tool (1.5-inch o.d.). Two inch i.d. boreholes may be tested using the slug test approach described in Section 5.
- For newly drilled wells, cuttings and drill fluids must be removed from the affected fractures by standard well development procedures.

2.) Review and record additional wellbore construction/site details and fill out the general well information form which includes the following information:

- Ambient depth-to-water
- Depth of casing
- Total depth of well
- Lithology (if available)
- Estimated well yield and any available drawdown data
- Type and concentration of contamination

3.) Prepare the deionized (DI) water. Consult with DI water tank firm for assistance if necessary. If DI water has not been transported to the site, surface or groundwater may be used if it is of suitable quality Generally source water containing less than 1000 micro Siemens per centimeter (μS/cm) and less then 200 ppb VOCs will not significantly affect the deionizing units, but this should be confirmed with DI water firm. If the groundwater from the well under construction cannot be used for DI water generation, then DI water must be transported to the site and containerized at the wellhead.

Depending on the amount of HydroPhysical™ testing to be performed (ambient and/or during production) the typical volume of DI water required for each borehole is approximately three times the volume of the standing column of formation water in the wellbore per type of HydroPhysical™ characterization.

If preparation takes place on site, pump the source water through a pre-filter, to the deionizing units, and into the storage tanks.

Monitor the FEC of the DI water in-line to verify homogeneity; the target value is 5 to 25 μS/cm.

4.) Calibrate the HydroPhysical™ logging tool using standard solutions prepared and certified by a qualified chemical supply manufacturer. Fill out tool calibration form following the steps defined in the software program, "tools" under the directory, calibration. Also use a separate field temperature / FEC / pH meter to support calibration data. Record the results of the tool calibrations, specifically noting any problems on the tool calibration form. Also record the certification number of the standard solutions.

5.) Set datum on the depth encoder with the FEC sensor on the tool as 0 depth at the top of casing. If inadequate space is available at the wellhead, measure 10 feet from the FEC sensor up the cable (using measuring tape) and reference with a wrap of electrical tape. Lower the tool down the hole to the point where the tape equals the elevation at the top of the casing and reference that as 10 feet depth on the depth encoder.

6.) Place the top of the tool approximately 3 feet below the free-water surface to allow it to achieve thermal equilibrium. Monitor the temperature output until thermal stabilization is observed at approximately $\pm$ .02 °C.

7.) After thermal stabilization of the logging tool is observed, log the ambient conditions of the wellbore (temperature and FEC). Fill out the water quality log form. During the logging run, the data are plotted in real time in log format on the computer screen and, the data string is simultaneously recorded on the hard drive.

Log the ambient fluid conditions in both directions (i.e. record down and up). The ideal logging speed is 5 feet per minute (fpm). For deeper wells the logging speed can be adjusted higher, but the fpm should not exceed 20.

At completion of the ambient log, place the tool approximately 10 feet below the free water surface. The tool will remain there during equipment set up as long as borehole conditions permit. Establish and record ambient depth to water using top of protective casing as datum.

8.) Attach back pressure regulator or orifice, if used, and weighted boot, to end of emplacement line and secure. Insure that the injection line is of adequate length to reach the bottom of the wellbore.

9.) Lower the flexible emplacement line to the bottom of the well allowing one foot of clearance from the well bottom to the outlet of the injection line.

10.) Lower tool about 10 feet below the water surface. The tool will be stationed beneath the submersible pump during non-logging times.

11.) Lower submersible pump in the well to a depth just above the logging tool. Record approximate depth of the pump location.

12.) Record all initial readings of gauges at elapsed time 0.0 minutes. Fill out well testing data form.

13.) Mark hoses with a round of electrical tape for reference. In addition, establish datum for tool depth to the nearest foot and mark on wire with wrap of tape. Reset datum on optical encoder for this depth.

14.) When ambient flow characterization is to be conducted, it should be done now, before disturbing the aquifer (i.e. by pumping). Fill out ambient flow characterization (AFC) form. Skip to Section 17 for procedures.

15.) After AFC, if performed, conduct a controlled, short term well production test (pump test) to characterize the overall hydraulics of the wellbore (drawdown at given pumping rate provides total well transmissivity or yield) and to make an initial assessment of formation water hydrochemistry. Begin pumping at a total extraction flow rate appropriate for wellbore under investigation (see Section 4 Special Notes). During this period, record elapsed time of pumping, depth to water, total gallons extracted, and extraction flow rate at approximately one minute intervals.

During extraction, log the fluid column continuously until at least three wellbore volumes have been extracted from the wellbore, or a stabilized water level elevation is obtained.

Review fluid logging results to verify that true formation water is present within the affected borehole interval and that the vertical distribution of water quality parameters within this interval is stable.

16.) Review data obtained during the pumping test to determine DI water emplacement and pumping/logging procedures. Extraction procedures for detection and characterization of hydraulically conductive intervals and the formation water hydrochemistry are determined based on the pumping test information. The emplacement, testing and pumping procedures will differ depending upon well yield and determined lengths of intervals of interest. In wellbore situations where intervals of interest are small (less than 30 feet) and hydraulic characteristics observed during borehole advancement and preliminary hydraulic testing indicate hydraulically conductive intervals with extremely low flow rates (i.e. <0.10 gpm/foot of drawdown), a slug testing procedure can be employed. In wellbore cases where the preliminary hydraulic testing indicates low to moderate total yield (i.e. $0.10 < Q < 4$ gpm/foot of drawdown), constant low flow rate pumping after DI water emplacement procedures can be employed. In wellbore situations where intervals of interest are large, and high total yield (i.e. > 4 gpm/foot of drawdown) is observed, constant pumping during DI water injection procedures will be employed.

17.) When the fluid column is to be replaced with DI water, (vertical flow characterization, slug testing, logging during pumping after DI water emplacement) the following emplacement procedures apply:

Pump the DI water to the bottom of the wellbore using the surface pump and the injection riser. Simultaneously use the submersible pump to maintain a stable, elevated total head by extracting groundwater from near the freewater surface. When groundwater from the subject well is used for DI water generation, generate DI water from the extracted formation water and recirculated to the well bottom via the solid riser.

Use the water level meter to observe the elevated total head during emplacement. If borehole conditions permit (i.e. the absence of constricted borehole intervals), the logging tool is used to monitor the advancement of the fluid up the borehole as it displaces the standing formation water. Draw the logging tool up the wellbore in successive increments as the DI water is emplaced. Monitor the electrical conductivity of the fluid expelled from the evacuation pump during emplacement procedures. When FEC values are representative of the DI water, or sufficiently diluted formation water, terminate emplacement procedures.

Emplacement is complete when DI water, or sufficiently diluted formation water, is observed from the evacuation pump or when logging tool stationed near the pump indicates DI water or sufficiently diluted formation water.

Upon completion, turn off the evacuation pump. Then turn off the injection line.

18.) Record volumes of extracted and injected fluids on the well testing data form. Calculate the volume of DI water lost to the formation.

19.) Take initial background HydroPhysical™ log, or begin continuous logging depending upon extraction method (i.e. slug vs. continuous).

20.) Pumping and testing procedures vary depending upon wellbore hydraulics and construction detail.

21.) Continuous logging is conducted until stabilized and consistent diluted FEC logs are observed. If inflow characterization at a second pumping rate is desired, increase extraction rate and assure the proper DI water injection rate. Perform continuous logging until stabilized and consistent FEC logs are observed and all diluted formation water is resaturated with formation water.

22.) After stabilized and consistent FEC traces are observed, terminate DI water injection. Reduce the total extraction flow rate to the net formation rate and conduct continuous logging. Conduct logging until stable and consistent FEC values are observed.

23.) Conduct depth specific sampling at this time.

24.) At the conclusion of the above procedures, assess the wellbore fluid conditions and compare them with those observed during the original pumping (Step 14).

25.) Turn all pumps off. First remove the extraction pump from the borehole. During removal, thoroughly clean the evacuation line (2-inch o.d.) with a brush and alconox and rinse DI water. Also clean the outside of the pump. Place the pump in a drum of DI water and flush DI water through the system.

Remove the tool. Clean the wireline for the tool in a similar manner during its withdrawal from the borehole.

Remove the injection line from the well. Follow the same procedures when cleaning the injection line as for the evacuation line.

Store the pumps and logging tools properly for transport.

Place cover on well and lock (if available).

4. Special Notes

On-site pre-treatment of groundwater using activated carbon, can be conducted prior to DI water generation, if there is a contaminated groundwater source. In addition, on-site treatment can also be considered to handle extracted fluids that would require containerization and treatment prior to disposal.

The rate(s) of pumping are determined by drawdown information previously obtained or at rate(s) appropriate for the wellbore diameter and saturated interval thickness. The appropriate extraction rate is a function of length of saturated interval, borehole diameter, and previous well yield knowledge. The appropriate pumping procedures to be employed are also dictated by the length of the exposed rock interval. In general, the extraction flow rate should be sufficient to induce adequate inflow from the producing intervals. The concern is that the extraction flow rate does not cause extreme drawdown within the well i.e. lowering the free water surface to within the interval of investigation.

5. Discussion

LOW YIELD: Extraction Slug Test After DI water Emplacement

In wells with very low total flow capability (i.e. < 0.10 gpm/foot of drawdown), perform a slug test in accordance with procedures developed by Hvorslev (1951). Rapidly extract a small volume of water from near the free water surface using the extraction riser and pump. A drop in piezometric head of about 2 feet should be adequate for the initial test. Record the rise in the free water surface with time and develop a conventional time-lag plot.

When the free water surface has recovered to a satisfactory elevation, log the wellbore fluid conditions. Repeat the procedures described above with successive increases in the drop of piezometric head (or volume extracted). Let the wellbore recover and record the rise in the free water surface. Repeat logging of the wellbore fluid after the free water surface has recovered to a satisfactory elevation. The number of slug tests performed is determined in the field after review of previous logging results.

MODERATE YIELD: Time Series HydroPhysical™ Logging During Continuous Pumping After DI water Emplacement

In the case of moderate yield wells (i.e. 0.10 < Y < 4 gpm/foot of drawdown), maintain a constant flow rate from the evacuation pump and record the total volume of groundwater evacuated from the wellbore. Employ a continuous reading pressure transducer (or equivalent device) to monitor the depressed total head during pumping, along with the associated pumping rate.

Hold the flow rate from the evacuation pump constant at a rate determined for the specific borehole. Drawdown of the free water surface produced during pumping should not overlap any identified water producing interval. Conduct hydrophysical logging continuously. The time interval is a function of flow rate and is specific to each well. The number of logging runs and the length of time required to conduct all loggings is a function of the particular hydraulic conditions. Logging and pumping is continued until the fluid column is resaturated with formation water (i.e. all DI water is removed from the borehole).

HIGH YIELD: Time Series Wellbore Fluid Logging During Continuous Pumping and Simultaneous DI Water Injection

When wells exhibit high yield (> 4 gpm/foot of drawdown), as determined by a review of the interval of interest, the borehole diameter and the results obtained from previous information and preliminary hydraulic testing, the appropriateness of time series fluid logging during continuous pumping and simultaneous DI water injection is determined.

In this case, maintain a constant flow rate from the evacuation pump and record this rate and the associated drawdown. During this period, conduct hydrophysical logging until reasonably similar HydroPhysical™ logs are observed and stabilized drawdown is achieved. After reasonably similar downhole fluid conditions are observed and simultaneous with extraction pumping, inject DI water at the bottom of the well at a constant rate of 10 to 20% of that employed for extraction. Increase the total rate of extraction to maintain total formation production reasonably similar to that prior to DI water injection (i.e. increase the total extraction by amount equal to the DI water injection rate).

Periodically record the total volume and flow rate of well fluids evacuated and the total volume and flow rate of DI water injected. Use a continuous reading pressure transducer or similar device to monitor the depressed total head during pumping. Record the depressed total head (piezometric surface) periodically, with the associated pumping and injection data.

The evacuation and DI water injection flow rates are held constant at a rate determined for the specific wellbore. Drawdown of the free water surface during pumping must not overlap any identified water producing intervals. HydroPhysical™ Logging is conducted continuously. The number of logging runs and the length of time required to conduct all loggings is a function of the particular hydraulic conditions exhibited by the well under investigation.

APPENDIX B

ESTIMATION OF HORIZONTAL FLOW

Estimation of Horizontal Flow From Ambient Condition Fluid Electrical Conductivity Logs Olin, Wilmington Site

Introduction

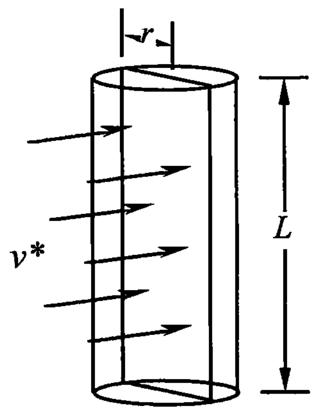
COLOG has examined the fluid electrical conductivity (FEC) logs that were acquired in three open wellbores related to the Olin, Wilmington site in Wilmington, MA. This examination and processing was conducted with experimental codes. The goal of the interpretation was to estimate the magnitude of horizontal groundwater velocity in discrete zones of the aquifer. The zones used in this analysis were delineated from FEC data sets. The results of this analysis is provided for each identified horizontal cross-flow zone, for a given well, in the main body of the report.

The data analyzed were assumed to be obtained in a reasonably stable ambient wellfield condition. No effort was made to correct the data for a possible disturbance to the aquifer by any outside influence.

The analysis of flow rates through each zone is based on borehole dilution theory in which a mixing model is used to infer horizontal groundwater flow velocity through a borehole. The borehole dilution technique is summarized in the textbook by Freeze and Cherry (1979) and is based on the work of Drost *et al.* (1968). Although the theory for such analysis is well established, its use in HydroPhysical™ logging experiments is innovative. Special considerations apply in using the theory with such applications; nonetheless, the theory provides promising results in such applications.

Theory

Consider a tracer (e.g., de-ionized water) that has been introduced uniformly into a section of a screened borehole. Let the observed concentration of the tracer be $C_{obs.}$ Once introduced, the concentration of the tracer is modified by formation water flowing into the borehole at a velocity v^*, as illustrated in the sketch below. Let the concentration of tracer in formation water be C_f. In HydroPhysical™ logging we can substitute fluid electrical conductivity (FEC) for concentration (so $C_{obs.}$ and C_f actually represent observed and formation FEC values). Because the tracer is de-ionized water, the borehole "dilution" will actually be an enrichment in fluid electrical conductivity.



Sketch 1. Schematic of borehole dilution process showing the definitions of geometric variables

By balancing the net rate of mass into the borehole with the rate of change of C_{obs}, we get the following first-order differential equation:

$$v^* C_f A - v^* C_{obs} A = W\frac{dC_{obs}}{dt} \qquad (1)$$

where A is the cross-sectional area of the borehole ($A = 2rL$), and W is the corresponding volume ($W = \pi r^2 L$). If we make the following change of variable

$$C = C_f - C_{obs} \qquad (2)$$

we get a somewhat simplified equation

$$v^* C = -\frac{W}{A}\frac{dC}{dt} \qquad (3)$$

that we can solve for C:

$$C = C_0 \exp(-\frac{2t}{\pi r} v^*) \qquad (4)$$

where $C_0 = (C_f - C_{obs}(t=0))$. Taking the log of both sides of (4) we get

$$\ln(C/C_0) = -\frac{2v^*}{\pi r} t \qquad (5)$$

Thus the ratio C/C_0 should plot as a linear change with time on semi-log paper. The slope of this line is proportional to the velocity of groundwater flowing through the well. Specifically,

$$v^* = -\frac{\pi r \ln(C_2/C_1)}{2(t_2 - t_1)} \qquad (6)$$

where t_1 and t_2 are times corresponding to values of C_1 and C_2 on the straight-line segment of the semi-log plot.

The velocity given by equation (6) is the velocity through the borehole, which may be different from the velocity of groundwater in the formation because flow lines tend to converge toward the borehole. Corrections for this convergence have been given by Drost *et al.* (1968) as

$$q = \frac{v^*}{\alpha} \qquad (7)$$

where q is the specific discharge of groundwater in the aquifer and α is a factor that accounts for convergence of flow lines. In general, calculating α requires detailed knowledge of the hydraulic properties of the screen, the gravel pack (or annulus around the screen if the well is naturally developed), and the hydraulic properties of the aquifer. For sand or gravel aquifers, α is usually between 0.5 and 4. However, to the knowledge of COLOG, these corrections have never been validated for the fractured open hole environment. While these values have been calculated using a convergence factor of 2.5, these results should be considered experimental until confirmed by traditional methods.

Interpretation and Results

In order to apply the borehole dilution technique to the appropriate logs, the data acquired in each zone was isolated. We then plotted all of the data for a particular zone against time on a semi-log graph. Using the slope of the lines plotted, we calculated groundwater velocity through each zone using equation (6).

In most of the logs the early-time FEC data do not fit a linear trend, presumably because de-ionized water was forced into the formation during the fluid exchange and/or the pressure had not stabilized; thus the water flowing into the well at early times is diluted formation water. As such the early time data was not considered in the slope calculations.

Please refer to the main body of the report for a brief discussion of the results for each well.

References

Freeze, R. A. and J. A. Cherry, 1979. *Groundwater*, Prentice Hall, Englewood Cliffs, 604p.

Drost, W., D. Klotz, A. Koch, H. Moser, F. Neumaier, and W. Rauert, 1968. Point dilution methods of investigating groundwater flow by means of radioisotopes, *Water Resour. Res.*, **4**, 125-146.

APPENDIX C

LIMITATIONS

LIMITATIONS

COLOG's logging was performed in accordance with generally accepted industry practices. COLOG has observed that degree of care and skill generally exercised by others under similar circumstances and conditions. Interpretations of logs or interpretations of test or other data, and any recommendation or hydrogeologic description based upon such interpretations, are opinions based upon inferences from measurements, empirical relationships and assumptions. These inferences and assumptions require engineering judgment, and therefore, are not scientific certainties. As such, other professional engineers or analysts may differ as to their interpretation. Accordingly, COLOG cannot and does not warrant the accuracy, correctness or completeness of any such interpretation, recommendation or hydrogeologic description.

All technical data, evaluations, analysis, reports, and other work products are instruments of COLOG's professional services intended for one-time use on this project. Any reuse of work product by Client for other than the purpose for which they were originally intended will be at Client's sole risk and without liability to COLOG. COLOG makes no warranties, either express or implied. Under no circumstances shall COLOG or its employees be liable for consequential damages.

Appendix E

OLIN CORPORATION

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME
C9S146M	Olin, Wilmington

SAMPLERS: *(Signature)* [signature]

Instructions: List samples individually. Write time in military time. Record sample type as water, soil, etc. and as grab or composite. Record special handling instructions or precautions in remarks section. Record method of shipment in comments section.

ANALYSES REQUIRED

Station or Sample No.	Date	Time	Sample Type	Number Of Containers	Sp. Gravity - Hydrometer	Ammonia	Sp. Cond, TA, Alk, Cl, SO4	VOC's	Metals	Hex Cr, NO2/NO3	Remarks
MP-4, 14	6/28/00	1530	WW	8	✓	✓	✓	✓	✓	✓	
MP-4, 13	6/28/00	1605	WW	8	✓	✓	✓	✓	✓	✓	
MP-4, 12	6/28/00	1645	WW	8	✓	✓	✓	✓	✓	✓	
MP-4, 11	6/28/00	1720	WW	8	✓	✓	✓	✓	✓	✓	
Dup A	6/28/00	—	WW	8	✓	✓	✓	✓	✓	✓	

Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*
[signature]	6/28/00 2000				
Relinquished by: *(Signature)*	**Date/Time**	**Received by:** *(Signature)*	**Relinquished by:** *(Signature)*	**Date/Time**	**Received by:** *(Signature)*
Relinquished by: *(Signature)*	**Date/Time**	**Received for Laboratory by:** *(Signature)*	**Date/Time**	**Comments**	

DISTRIBUTION: Original and Pink copies accompany sample shipment to laboratory. Pink copy retained by laboratory. Yellow copy retained by samplers.

OLIN CORPORATION

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME
C44146M	Olin, Wilmington

SAMPLERS: *(Signature)* [signature]

Station or Sample No.	Date	Time	Sample Type	Number Of Containers	Sp. Gravity Hydrometer	Ammonia pH Alk	Sp. Cond Cl SO4	Metals	Hex Cr NO2/NO3		Remarks
OP-4, 1	6/29/00	1340	WW	5	✓	✓	✓	✓	✓		
OP-4, 8	6/29/00	1435	WW	5	✓	✓	✓	✓	✓		
OP-4, 5	6/29/00	1505	WW	5	✓	✓	✓	✓	✓		
OP-4, 3	6/29/00	1545	WW	5	✓	✓	✓	✓	✓		
OP-4, 2	6/29/00	1610	WW	5	✓	✓	✓	✓	✓		

Instructions: List samples individually. Write time in military time. Record sample type as water, soil, etc. and as grab or composite. Record special handling instructions or precautions in remarks section. Record method of shipment in comments section.

Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*
[signature]	6/29/00 2000				

Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*

Relinquished by: *(Signature)*	Date/Time	Received for Laboratory by: *(Signature)*	Date/Time	Comments

DISTRIBUTION: Original and Pink copies accompany sample shipment to laboratory. Pink copy retained by laboratory. Yellow copy retained by samplers.

OLIN CORPORATION

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME
CS9146M	Olin Wilmington

SAMPLERS: *(Signature)* [signature]

Instructions: List samples individually. Write time in military time. Record sample type as water, soil, etc. and as grab or composite. Record special handling instructions or precautions in remarks section. Record method of shipment in comments section.

Station or Sample No.	Date	Time	Sample Type	Number Of Containers	ANALYSES REQUIRED: [illegible] Hydrocarbons	Ammonia	Sp. Cond, Cl, SO4, Alk	Metals	Hex Cr, NO3/NO2		Remarks
MP-4, 9	6/29/00	1635	GW	5	✓	✓	✓	✓	✓		
MP-4, 10	6/29/00	1728	GW	5	✓	✓	✓	✓	✓		

Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*
[signature]	6/28/00 2000				
Relinquished by: *(Signature)*	**Date/Time**	**Received by:** *(Signature)*	**Relinquished by:** *(Signature)*	**Date/Time**	**Received by:** *(Signature)*
Relinquished by: *(Signature)*	**Date/Time**	**Received for Laboratory by:** *(Signature)*	**Date/Time**	**Comments**	

DISTRIBUTION: Original and Pink copies accompany sample shipment to laboratory. Pink copy retained by laboratory. Yellow copy retained by samplers.

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151178	MP-4 14	6/29/2000	6/28/2000	Specific Gravity		0.97			ASTM D1298	7/10/2000
151178	MP-4 14	6/29/2000	6/28/2000	pH		6.45		pH units	EPA 150.1	6/30/2000
151178	MP-4 14	6/29/2000	6/28/2000	Aluminum	7429-90-5	100U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Barium	7440-39-3	19		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Cadmium	7440-43-9	2U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Calcium	7440-70-2	8700		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Chromium	7440-47-3	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Cobalt	7440-48-4	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Copper	7440-50-8	20U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Iron	7439-89-6	520		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Lead	7439-92-1	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Magnesium	7439-95-4	1900		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Manganese	7439-96-5	510		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Nickel	7440-02-0	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Potassium	7440-09-7	4100		ug/L	EPA 200.7	7/20/2000
151178	MP-4 14	6/29/2000	6/28/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Sodium	7440-23-5	180000		ug/L	EPA 200.7	7/27/2000
151178	MP-4 14	6/29/2000	6/28/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Zinc	7440-66-6	50U		ug/L	EPA 200.7	7/13/2000
151178	MP-4 14	6/29/2000	6/28/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151178	MP-4 14	6/29/2000	6/28/2000	Sulfate		12		mg/L	EPA 300	7/5/2000
151178	MP-4 14	6/29/2000	6/28/2000	Nitrate Nitrogen as N		2.0		mg/L	LAC107041A	6/30/2000
151178	MP-4 14	6/29/2000	6/28/2000	Ammonia Nitrogen as N		2.5		mg/L	LAC107061A	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Chloride		32		mg/L	LAC117071A	7/3/2000
151178	MP-4 14	6/29/2000	6/28/2000	Bicarbonate Alkalinity		22		mg/L	SM18 2320B	7/6/2000
151178	MP-4 14	6/29/2000	6/28/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151178	MP-4 14	6/29/2000	6/28/2000	Specific Conductivity		205		umhos/cm	SM18 2510B	7/10/2000
151178	MP-4 14	6/29/2000	6/28/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/29/2000
151178	MP-4 14	6/29/2000	6/28/2000	Nitrite Nitrogen as N		0.01U		mg/L	SM4500NO2B	6/30/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,1,1-Trichloroethane	71-55-6	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,1,2,2-Tetrachloroethane	79-34-5	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,1,2-Trichloroethane	79-00-5	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,1-Dichloroethane	75-34-3	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,1-Dichloroethene	75-35-4	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,2- Dibromoethane	106-93-4	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,2-Dichlorobenzene	95-50-1	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,2-Dichloroethane	107-06-2	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,2-Dichloropropane	78-87-5	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,3-Dichlorobenzene	541-73-1	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	1,4-Dichlorobenzene	106-46-7	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	2,4,4-Trimethyl 1-pentene	107-39-1	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	2,4,4-Trimethyl 2-pentene	107-40-4	U	5.0	ug/L	EPA 624	7/11/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151178	MP-4 14	6/29/2000	6/28/2000	2-Butanone	78-93-3	U	20	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	2-Hexanone	591-78-6	U	20	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	4-Methyl-2-pentanone	108-10-1	U	20	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Acetone	67-64-1	U	10	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Benzene	71-43-2	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Bromodichloromethane	75-27-4	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Bromoform	75-25-2	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Bromomethane	74-83-9	U	7.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Carbon disulfide	75-15-0	U	10	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Carbon tetrachloride	56-23-5	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Chlorobenzene	108-90-7	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Chloroethane	75-00-3	U	10	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Chloroform	67-66-3	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Chloromethane	74-87-3	U	10	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	cis-1,2-Dichloroethene	156-59-2	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	cis-1,3-Dichloropropene	10061-01-5	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Dibromochloromethane	124-48-1	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Ethylbenzene	100-41-4	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Fluorotrichloromethane	75-69-4	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Methyl-t-butyl ether	1634-04-4	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Methylene chloride	75-09-2	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Styrene	100-42-5	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Tetrachloroethene	127-18-4	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Toluene	108-88-3	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Total-1,2-dichloroethene		U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	trans-1,3-Dichloropropene	10061-02-6	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Trichloroethene	79-01-6	U	5.0	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Vinyl Acetate	108-05-4	U	50	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Vinyl chloride	75-01-4	U	10	ug/L	EPA 624	7/11/2000
151178	MP-4 14	6/29/2000	6/28/2000	Xylenes,total		U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Specific Gravity		0.98			ASTM D1298	7/10/2000
151179	MP-4 13	6/29/2000	6/28/2000	pH		6.35		pH units	EPA 150.1	6/30/2000
151179	MP-4 13	6/29/2000	6/28/2000	Aluminum	7429-90-5	100U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Barium	7440-39-3	66		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Cadmium	7440-43-9	2U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Calcium	7440-70-2	12000		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Chromium	7440-47-3	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Cobalt	7440-48-4	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Copper	7440-50-8	20U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Iron	7439-89-6	11000		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Lead	7439-92-1	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Magnesium	7439-95-4	2200		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Manganese	7439-96-5	1200		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Nickel	7440-02-0	10U		ug/L	EPA 200.7	7/13/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151179	MP-4 13	6/29/2000	6/28/2000	Potassium	7440-09-7	3800		ug/L	EPA 200.7	7/20/2000
151179	MP-4 13	6/29/2000	6/28/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Sodium	7440-23-5	51000		ug/L	EPA 200.7	7/27/2000
151179	MP-4 13	6/29/2000	6/28/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Zinc	7440-66-6	50U		ug/L	EPA 200.7	7/13/2000
151179	MP-4 13	6/29/2000	6/28/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151179	MP-4 13	6/29/2000	6/28/2000	Sulfate		15		mg/L	EPA 300	7/5/2000
151179	MP-4 13	6/29/2000	6/28/2000	Nitrate Nitrogen as N		0.65		mg/L	LAC107041A	6/30/2000
151179	MP-4 13	6/29/2000	6/28/2000	Ammonia Nitrogen as N		9.2		mg/L	LAC107061A	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Chloride		62		mg/L	LAC117071A	7/3/2000
151179	MP-4 13	6/29/2000	6/28/2000	Bicarbonate Alkalinity		79		mg/L	SM18 2320B	7/6/2000
151179	MP-4 13	6/29/2000	6/28/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151179	MP-4 13	6/29/2000	6/28/2000	Specific Conductivity		439		umhos/cm	SM18 2510B	7/10/2000
151179	MP-4 13	6/29/2000	6/28/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/29/2000
151179	MP-4 13	6/29/2000	6/28/2000	Nitrite Nitrogen as N		0.017		mg/L	SM4500NO2B	6/30/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,1,1-Trichloroethane	71-55-6	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,1,2,2-Tetrachloroethane	79-34-5	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,1,2-Trichloroethane	79-00-5	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,1-Dichloroethane	75-34-3	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,1-Dichloroethene	75-35-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,2- Dibromoethane	106-93-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,2-Dichlorobenzene	95-50-1	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,2-Dichloroethane	107-06-2	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,2-Dichloropropane	78-87-5	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,3-Dichlorobenzene	541-73-1	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	1,4-Dichlorobenzene	106-46-7	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	2,4,4-Trimethyl 1-pentene	107-39-1	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	2,4,4-Trimethyl 2-pentene	107-40-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	2-Butanone	78-93-3	U	20	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	2-Hexanone	591-78-6	U	20	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	4-Methyl-2-pentanone	108-10-1	U	20	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Acetone	67-64-1	U	10	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Benzene	71-43-2	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Bromodichloromethane	75-27-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Bromoform	75-25-2	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Bromomethane	74-83-9	U	7.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Carbon disulfide	75-15-0	U	10	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Carbon tetrachloride	56-23-5	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Chlorobenzene	108-90-7	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Chloroethane	75-00-3	U	10	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Chloroform	67-66-3	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Chloromethane	74-87-3	5.6	10	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	cis-1,2-Dichloroethene	156-59-2	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	cis-1,3-Dichloropropene	10061-01-5	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Dibromochloromethane	124-48-1	U	5.0	ug/L	EPA 624	7/11/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151179	MP-4 13	6/29/2000	6/28/2000	Ethylbenzene	100-41-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Fluorotrichloromethane	75-69-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Methyl-t-butyl ether	1634-04-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Methylene chloride	75-09-2	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Styrene	100-42-5	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Tetrachloroethene	127-18-4	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Toluene	108-88-3	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Total-1,2-dichloroethene		U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	trans-1,3-Dichloropropene	10061-02-6	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Trichloroethene	79-01-6	U	5.0	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Vinyl Acetate	108-05-4	U	50	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Vinyl chloride	75-01-4	U	10	ug/L	EPA 624	7/11/2000
151179	MP-4 13	6/29/2000	6/28/2000	Xylenes,total		U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Specific Gravity		0.98			ASTM D1298	7/10/2000
151180	MP-4 12	6/29/2000	6/28/2000	pH		6.40		pH units	EPA 150.1	6/30/2000
151180	MP-4 12	6/29/2000	6/28/2000	Sulfate		43		mg/L	EPA 300	7/5/2000
151180	MP-4 12	6/29/2000	6/28/2000	Nitrate Nitrogen as N		3.1		mg/L	LAC107041A	6/30/2000
151180	MP-4 12	6/29/2000	6/28/2000	Ammonia Nitrogen as N		30		mg/L	LAC107061A	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Chloride		150		mg/L	LAC117071A	7/3/2000
151180	MP-4 12	6/29/2000	6/28/2000	Bicarbonate Alkalinity		120		mg/L	SM18 2320B	7/6/2000
151180	MP-4 12	6/29/2000	6/28/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151180	MP-4 12	6/29/2000	6/28/2000	Specific Conductivity		905		umhos/cm	SM18 2510B	7/10/2000
151180	MP-4 12	6/29/2000	6/28/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/29/2000
151180	MP-4 12	6/29/2000	6/28/2000	Nitrite Nitrogen as N		0.084		mg/L	SM4500NO2B	6/30/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,1,1-Trichloroethane	71-55-6	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,1,2,2-Tetrachloroethane	79-34-5	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,1,2-Trichloroethane	79-00-5	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,1-Dichloroethane	75-34-3	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,1-Dichloroethene	75-35-4	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,2- Dibromoethane	106-93-4	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,2-Dichlorobenzene	95-50-1	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,2-Dichloroethane	107-06-2	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,2-Dichloropropane	78-87-5	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,3-Dichlorobenzene	541-73-1	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	1,4-Dichlorobenzene	106-46-7	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	2,4,4-Trimethyl 1-pentene	107-39-1	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	2,4,4-Trimethyl 2-pentene	107-40-4	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	2-Butanone	78-93-3	U	20	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	2-Hexanone	591-78-6	U	20	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	4-Methyl-2-pentanone	108-10-1	U	20	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Acetone	67-64-1	U	10	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Benzene	71-43-2	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Bromodichloromethane	75-27-4	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Bromoform	75-25-2	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Bromomethane	74-83-9	U	7.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Carbon disulfide	75-15-0	U	10	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Carbon tetrachloride	56-23-5	U	5.0	ug/L	EPA 624	7/11/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151180	MP-4 12	6/29/2000	6/28/2000	Chlorobenzene	108-90-7	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Chloroethane	75-00-3	U	10	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Chloroform	67-66-3	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Chloromethane	74-87-3	7.3	10	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	cis-1,2-Dichloroethene	156-59-2	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	cis-1,3-Dichloropropene	10061-01-5	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Dibromochloromethane	124-48-1	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Ethylbenzene	100-41-4	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Fluorotrichloromethane	75-69-4	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Methyl-t-butyl ether	1634-04-4	11	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Methylene chloride	75-09-2	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Styrene	100-42-5	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Tetrachloroethene	127-18-4	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Toluene	108-88-3	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Total-1,2-dichloroethene		U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	trans-1,3-Dichloropropene	10061-02-6	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Trichloroethene	79-01-6	U	5.0	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Vinyl Acetate	108-05-4	U	50	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Vinyl chloride	75-01-4	U	10	ug/L	EPA 624	7/11/2000
151180	MP-4 12	6/29/2000	6/28/2000	Xylenes,total		U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Specific Gravity		0.99			ASTM D1298	7/10/2000
151181	MP-4 11	6/29/2000	6/28/2000	pH		6.67		pH units	EPA 150.1	6/30/2000
151181	MP-4 11	6/29/2000	6/28/2000	Aluminum	7429-90-5	100U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Barium	7440-39-3	68		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Cadmium	7440-43-9	2U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Calcium	7440-70-2	100000		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Chromium	7440-47-3	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Cobalt	7440-48-4	37		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Copper	7440-50-8	20U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Iron	7439-89-6	24000		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Lead	7439-92-1	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Magnesium	7439-95-4	23000		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Manganese	7439-96-5	13000		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Nickel	7440-02-0	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Potassium	7440-09-7	9200		ug/L	EPA 200.7	7/20/2000
151181	MP-4 11	6/29/2000	6/28/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Sodium	7440-23-5	330000		ug/L	EPA 200.7	7/27/2000
151181	MP-4 11	6/29/2000	6/28/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Zinc	7440-66-6	50U		ug/L	EPA 200.7	7/13/2000
151181	MP-4 11	6/29/2000	6/28/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151181	MP-4 11	6/29/2000	6/28/2000	Sulfate		760		mg/L	EPA 300	7/5/2000
151181	MP-4 11	6/29/2000	6/28/2000	Nitrate Nitrogen as N		0.26		mg/L	LAC107041A	6/30/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151181	MP-4 11	6/29/2000	6/28/2000	Ammonia Nitrogen as N		120		mg/L	LAC107061A	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Chloride		490		mg/L	LAC117071A	7/3/2000
151181	MP-4 11	6/29/2000	6/28/2000	Bicarbonate Alkalinity		230		mg/L	SM18 2320B	7/6/2000
151181	MP-4 11	6/29/2000	6/28/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151181	MP-4 11	6/29/2000	6/28/2000	Specific Conductivity		3610		umhos/cm	SM18 2510B	7/10/2000
151181	MP-4 11	6/29/2000	6/28/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/29/2000
151181	MP-4 11	6/29/2000	6/28/2000	Nitrite Nitrogen as N		0.01U		mg/L	SM4500NO2B	6/30/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,1,1-Trichloroethane	71-55-6	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,1,2,2-Tetrachloroethane	79-34-5	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,1,2-Trichloroethane	79-00-5	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,1-Dichloroethane	75-34-3	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,1-Dichloroethene	75-35-4	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,2- Dibromoethane	106-93-4	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,2-Dichlorobenzene	95-50-1	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,2-Dichloroethane	107-06-2	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,2-Dichloropropane	78-87-5	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,3-Dichlorobenzene	541-73-1	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	1,4-Dichlorobenzene	106-46-7	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	2,4,4-Trimethyl 1-pentene	107-39-1	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	2,4,4-Trimethyl 2-pentene	107-40-4	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	2-Butanone	78-93-3	U	20	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	2-Hexanone	591-78-6	U	20	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	4-Methyl-2-pentanone	108-10-1	U	20	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Acetone	67-64-1	U	10	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Benzene	71-43-2	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Bromodichloromethane	75-27-4	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Bromoform	75-25-2	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Bromomethane	74-83-9	U	7.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Carbon disulfide	75-15-0	U	10	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Carbon tetrachloride	56-23-5	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Chlorobenzene	108-90-7	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Chloroethane	75-00-3	U	10	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Chloroform	67-66-3	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Chloromethane	74-87-3	U	10	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	cis-1,2-Dichloroethene	156-59-2	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	cis-1,3-Dichloropropene	10061-01-5	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Dibromochloromethane	124-48-1	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Ethylbenzene	100-41-4	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Fluorotrichloromethane	75-69-4	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Methyl-t-butyl ether	1634-04-4	12	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Methylene chloride	75-09-2	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Styrene	100-42-5	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Tetrachloroethene	127-18-4	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Toluene	108-88-3	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Total-1,2-dichloroethene		U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	trans-1,3-Dichloropropene	10061-02-6	U	5.0	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Trichloroethene	79-01-6	U	5.0	ug/L	EPA 624	7/11/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151181	MP-4 11	6/29/2000	6/28/2000	Vinyl Acetate	108-05-4	U	50	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Vinyl chloride	75-01-4	U	10	ug/L	EPA 624	7/11/2000
151181	MP-4 11	6/29/2000	6/28/2000	Xylenes,total		U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Specific Gravity		0.99			ASTM D1298	7/10/2000
151182	DUP A	6/29/2000	6/28/2000	pH		6.60		pH units	EPA 150.1	6/30/2000
151182	DUP A	6/29/2000	6/28/2000	Aluminum	7429-90-5	100U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Barium	7440-39-3	66		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Cadmium	7440-43-9	2U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Calcium	7440-70-2	100000		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Chromium	7440-47-3	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Cobalt	7440-48-4	38		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Copper	7440-50-8	20U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Iron	7439-89-6	24000		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Lead	7439-92-1	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Magnesium	7439-95-4	23000		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Manganese	7439-96-5	13000		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Nickel	7440-02-0	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Potassium	7440-09-7	9800		ug/L	EPA 200.7	7/20/2000
151182	DUP A	6/29/2000	6/28/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Sodium	7440-23-5	330000		ug/L	EPA 200.7	7/27/2000
151182	DUP A	6/29/2000	6/28/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Zinc	7440-66-6	50U		ug/L	EPA 200.7	7/13/2000
151182	DUP A	6/29/2000	6/28/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151182	DUP A	6/29/2000	6/28/2000	Sulfate		800		mg/L	EPA 300	7/6/2000
151182	DUP A	6/29/2000	6/28/2000	Nitrate Nitrogen as N		0.068		mg/L	LAC107041A	6/30/2000
151182	DUP A	6/29/2000	6/28/2000	Ammonia Nitrogen as N		160		mg/L	LAC107061A	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Chloride		490		mg/L	LAC117071A	7/3/2000
151182	DUP A	6/29/2000	6/28/2000	Bicarbonate Alkalinity		230		mg/L	SM18 2320B	7/6/2000
151182	DUP A	6/29/2000	6/28/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151182	DUP A	6/29/2000	6/28/2000	Specific Conductivity		3600		umhos/cm	SM18 2510B	7/10/2000
151182	DUP A	6/29/2000	6/28/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/29/2000
151182	DUP A	6/29/2000	6/28/2000	Nitrite Nitrogen as N		0.01U		mg/L	SM4500NO2B	6/30/2000
151182	DUP A	6/29/2000	6/28/2000	1,1,1-Trichloroethane	71-55-6	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,1,2,2-Tetrachloroethane	79-34-5	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,1,2-Trichloroethane	79-00-5	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,1-Dichloroethane	75-34-3	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,1-Dichloroethene	75-35-4	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,2- Dibromoethane	106-93-4	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,2-Dichlorobenzene	95-50-1	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,2-Dichloroethane	107-06-2	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,2-Dichloropropane	78-87-5	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	1,3-Dichlorobenzene	541-73-1	U	5.0	ug/L	EPA 624	7/11/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151182	DUP A	6/29/2000	6/28/2000	1,4-Dichlorobenzene	106-46-7	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	2,4,4-Trimethyl 1-pentene	107-39-1	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	2,4,4-Trimethyl 2-pentene	107-40-4	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	2-Butanone	78-93-3	U	20	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	2-Hexanone	591-78-6	U	20	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	4-Methyl-2-pentanone	108-10-1	U	20	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Acetone	67-64-1	U	10	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Benzene	71-43-2	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Bromodichloromethane	75-27-4	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Bromoform	75-25-2	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Bromomethane	74-83-9	U	7.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Carbon disulfide	75-15-0	U	10	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Carbon tetrachloride	56-23-5	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Chlorobenzene	108-90-7	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Chloroethane	75-00-3	U	10	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Chloroform	67-66-3	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Chloromethane	74-87-3	U	10	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	cis-1,2-Dichloroethene	156-59-2	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	cis-1,3-Dichloropropene	10061-01-5	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Dibromochloromethane	124-48-1	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Ethylbenzene	100-41-4	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Fluorotrichloromethane	75-69-4	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Methyl-t-butyl ether	1634-04-4	14	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Methylene chloride	75-09-2	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Styrene	100-42-5	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Tetrachloroethene	127-18-4	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Toluene	108-88-3	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Total-1,2-dichloroethene		U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	trans-1,3-Dichloropropene	10061-02-6	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Trichloroethene	79-01-6	U	5.0	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Vinyl Acetate	108-05-4	U	50	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Vinyl chloride	75-01-4	U	10	ug/L	EPA 624	7/11/2000
151182	DUP A	6/29/2000	6/28/2000	Xylenes,total		U	5.0	ug/L	EPA 624	7/11/2000
151240	MP-4 9	6/30/2000	6/29/2000	Specific Gravity		1.02			ASTM D1298	7/10/2000
151240	MP-4 9	6/30/2000	6/29/2000	pH		4.29		pH units	EPA 150.1	6/30/2000
151240	MP-4 9	6/30/2000	6/29/2000	Aluminum	7429-90-5	24000		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Antimony	7440-36-0	300		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Arsenic	7440-38-2	37		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Barium	7440-39-3	34		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Beryllium	7440-41-7	29		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Cadmium	7440-43-9	28		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Calcium	7440-70-2	420000		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Chromium	7440-47-3	40000		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Cobalt	7440-48-4	1200		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Copper	7440-50-8	210		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Iron	7439-89-6	580000		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Lead	7439-92-1	25U		ug/L	EPA 200.7	7/17/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151240	MP-4 9	6/30/2000	6/29/2000	Magnesium	7439-95-4	280000		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Manganese	7439-96-5	54000		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Nickel	7440-02-0	1500		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Potassium	7440-09-7	25000		ug/L	EPA 200.7	7/20/2000
151240	MP-4 9	6/30/2000	6/29/2000	Selenium	7782-49-2	25U		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Silver	7440-22-4	25U		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Sodium	7440-23-5	2600000		ug/L	EPA 200.7	7/27/2000
151240	MP-4 9	6/30/2000	6/29/2000	Thallium	7440-28-0	25U		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Vanadium	7440-62-2	25U		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Zinc	7440-66-6	2600		ug/L	EPA 200.7	7/17/2000
151240	MP-4 9	6/30/2000	6/29/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151240	MP-4 9	6/30/2000	6/29/2000	Sulfate		9200		mg/L	EPA 300	7/5/2000
151240	MP-4 9	6/30/2000	6/29/2000	Nitrate Nitrogen as N		0.05U		mg/L	LAC107041A	6/30/2000
151240	MP-4 9	6/30/2000	6/29/2000	Ammonia Nitrogen as N		2100		mg/L	LAC107061A	7/11/2000
151240	MP-4 9	6/30/2000	6/29/2000	Chloride		4500		mg/L	LAC117071A	7/3/2000
151240	MP-4 9	6/30/2000	6/29/2000	Bicarbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151240	MP-4 9	6/30/2000	6/29/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151240	MP-4 9	6/30/2000	6/29/2000	Specific Conductivity		255000		umhos/cm	SM18 2510B	7/10/2000
151240	MP-4 9	6/30/2000	6/29/2000	Chromium, hexavalent	18540-29-9	0.014		mg/L	SM18 3500D	6/30/2000
151240	MP-4 9	6/30/2000	6/29/2000	Nitrite Nitrogen as N		0.01U		mg/L	SM4500NO2B	6/30/2000
151241	MP-4 10	6/30/2000	6/29/2000	Specific Gravity		1.02			ASTM D1298	7/10/2000
151241	MP-4 10	6/30/2000	6/29/2000	pH		4.44		pH units	EPA 150.1	6/30/2000
151241	MP-4 10	6/30/2000	6/29/2000	Aluminum	7429-90-5	110000		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Antimony	7440-36-0	81		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Arsenic	7440-38-2	25U		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Barium	7440-39-3	26		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Beryllium	7440-41-7	17		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Cadmium	7440-43-9	19		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Calcium	7440-70-2	340000		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Chromium	7440-47-3	11000		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Cobalt	7440-48-4	760		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Copper	7440-50-8	240		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Iron	7439-89-6	450000		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Lead	7439-92-1	25U		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Magnesium	7439-95-4	180000		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Manganese	7439-96-5	50000		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Nickel	7440-02-0	930		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Potassium	7440-09-7	20000		ug/L	EPA 200.7	7/20/2000
151241	MP-4 10	6/30/2000	6/29/2000	Selenium	7782-49-2	25U		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Silver	7440-22-4	25U		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Sodium	7440-23-5	1800000		ug/L	EPA 200.7	7/27/2000
151241	MP-4 10	6/30/2000	6/29/2000	Thallium	7440-28-0	25U		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Vanadium	7440-62-2	25U		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Zinc	7440-66-6	1600		ug/L	EPA 200.7	7/17/2000
151241	MP-4 10	6/30/2000	6/29/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151241	MP-4 10	6/30/2000	6/29/2000	Sulfate		7200		mg/L	EPA 300	7/5/2000
151241	MP-4 10	6/30/2000	6/29/2000	Nitrate Nitrogen as N		0.05U		mg/L	LAC107041A	6/30/2000
151241	MP-4 10	6/30/2000	6/29/2000	Ammonia Nitrogen as N		1900		mg/L	LAC107061A	7/11/2000
151241	MP-4 10	6/30/2000	6/29/2000	Chloride		4100		mg/L	LAC117071A	7/3/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151241	MP-4 10	6/30/2000	6/29/2000	Bicarbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151241	MP-4 10	6/30/2000	6/29/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151241	MP-4 10	6/30/2000	6/29/2000	Specific Conductivity		19500		umhos/cm	SM18 2510B	7/10/2000
151241	MP-4 10	6/30/2000	6/29/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/30/2000
151241	MP-4 10	6/30/2000	6/29/2000	Nitrite Nitrogen as N		0.01U		mg/L	SM4500NO2B	6/30/2000
151242	MP-4 1	6/30/2000	6/29/2000	Specific Gravity		1.02			ASTM D1298	7/10/2000
151242	MP-4 1	6/30/2000	6/29/2000	pH		6.47		pH units	EPA 150.1	6/30/2000
151242	MP-4 1	6/30/2000	6/29/2000	Aluminum	7429-90-5	190		ug/L	EPA 200.7	7/17/2000
151242	MP-4 1	6/30/2000	6/29/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Barium	7440-39-3	15		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Cadmium	7440-43-9	4.6		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Calcium	7440-70-2	420000		ug/L	EPA 200.7	7/13/2000
151242	MP-4 1	6/30/2000	6/29/2000	Chromium	7440-47-3	58		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Cobalt	7440-48-4	310		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Copper	7440-50-8	20U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Iron	7439-89-6	22000		ug/L	EPA 200.7	7/13/2000
151242	MP-4 1	6/30/2000	6/29/2000	Lead	7439-92-1	10U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Magnesium	7439-95-4	140000		ug/L	EPA 200.7	7/13/2000
151242	MP-4 1	6/30/2000	6/29/2000	Manganese	7439-96-5	12000		ug/L	EPA 200.7	7/17/2000
151242	MP-4 1	6/30/2000	6/29/2000	Nickel	7440-02-0	230		ug/L	EPA 200.7	7/17/2000
151242	MP-4 1	6/30/2000	6/29/2000	Potassium	7440-09-7	16000		ug/L	EPA 200.7	7/20/2000
151242	MP-4 1	6/30/2000	6/29/2000	Selenium	7782-49-2	19		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Sodium	7440-23-5	4400000		ug/L	EPA 200.7	7/27/2000
151242	MP-4 1	6/30/2000	6/29/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Zinc	7440-66-6	150		ug/L	EPA 200.7	7/13/2000
151242	MP-4 1	6/30/2000	6/29/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151242	MP-4 1	6/30/2000	6/29/2000	Sulfate		9100		mg/L	EPA 300	7/5/2000
151242	MP-4 1	6/30/2000	6/29/2000	Nitrate Nitrogen as N		17		mg/L	LAC107041A	6/30/2000
151242	MP-4 1	6/30/2000	6/29/2000	Ammonia Nitrogen as N		490		mg/L	LAC107061A	7/11/2000
151242	MP-4 1	6/30/2000	6/29/2000	Chloride		4900		mg/L	LAC117071A	7/3/2000
151242	MP-4 1	6/30/2000	6/29/2000	Bicarbonate Alkalinity		690		mg/L	SM18 2320B	7/6/2000
151242	MP-4 1	6/30/2000	6/29/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151242	MP-4 1	6/30/2000	6/29/2000	Specific Conductivity		250000		umhos/cm	SM18 2510B	7/10/2000
151242	MP-4 1	6/30/2000	6/29/2000	Chromium, hexavalent	18540-29-9	0.008		mg/L	SM18 3500D	6/30/2000
151242	MP-4 1	6/30/2000	6/29/2000	Nitrite Nitrogen as N		0.087		mg/L	SM4500NO2B	6/30/2000
151243	MP-4 8	6/30/2000	6/29/2000	Specific Gravity		1.02			ASTM D1298	7/10/2000
151243	MP-4 8	6/30/2000	6/29/2000	pH		5.32		pH units	EPA 150.1	6/30/2000
151243	MP-4 8	6/30/2000	6/29/2000	Aluminum	7429-90-5	30000		ug/L	EPA 200.7	7/17/2000
151243	MP-4 8	6/30/2000	6/29/2000	Antimony	7440-36-0	28		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Arsenic	7440-38-2	22		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Barium	7440-39-3	46		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Beryllium	7440-41-7	9.3		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Cadmium	7440-43-9	37		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Calcium	7440-70-2	480000		ug/L	EPA 200.7	7/13/2000
151243	MP-4 8	6/30/2000	6/29/2000	Chromium	7440-47-3	5500		ug/L	EPA 200.7	7/11/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151243	MP-4 8	6/30/2000	6/29/2000	Cobalt	7440-48-4	1600		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Copper	7440-50-8	200		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Iron	7439-89-6	740000		ug/L	EPA 200.7	7/13/2000
151243	MP-4 8	6/30/2000	6/29/2000	Lead	7439-92-1	10		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Magnesium	7439-95-4	640000		ug/L	EPA 200.7	7/19/2000
151243	MP-4 8	6/30/2000	6/29/2000	Manganese	7439-96-5	57000		ug/L	EPA 200.7	7/17/2000
151243	MP-4 8	6/30/2000	6/29/2000	Nickel	7440-02-0	2100		ug/L	EPA 200.7	7/17/2000
151243	MP-4 8	6/30/2000	6/29/2000	Potassium	7440-09-7	25000		ug/L	EPA 200.7	7/20/2000
151243	MP-4 8	6/30/2000	6/29/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Sodium	7440-23-5	3300000		ug/L	EPA 200.7	7/27/2000
151243	MP-4 8	6/30/2000	6/29/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Zinc	7440-66-6	3300		ug/L	EPA 200.7	7/13/2000
151243	MP-4 8	6/30/2000	6/29/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151243	MP-4 8	6/30/2000	6/29/2000	Sulfate		9500		mg/L	EPA 300	7/5/2000
151243	MP-4 8	6/30/2000	6/29/2000	Nitrate Nitrogen as N		0.92		mg/L	LAC107041A	6/30/2000
151243	MP-4 8	6/30/2000	6/29/2000	Ammonia Nitrogen as N		2100		mg/L	LAC107061A	7/11/2000
151243	MP-4 8	6/30/2000	6/29/2000	Chloride		6700		mg/L	LAC117071A	7/3/2000
151243	MP-4 8	6/30/2000	6/29/2000	Bicarbonate Alkalinity		24		mg/L	SM18 2320B	7/6/2000
151243	MP-4 8	6/30/2000	6/29/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151243	MP-4 8	6/30/2000	6/29/2000	Specific Conductivity		292000		umhos/cm	SM18 2510B	7/10/2000
151243	MP-4 8	6/30/2000	6/29/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/30/2000
151243	MP-4 8	6/30/2000	6/29/2000	Nitrite Nitrogen as N		0.01U		mg/L	SM4500NO2B	6/30/2000
151244	MP-4 5	6/30/2000	6/29/2000	Specific Gravity		1.03			ASTM D1298	7/10/2000
151244	MP-4 5	6/30/2000	6/29/2000	pH		6.18		pH units	EPA 150.1	6/30/2000
151244	MP-4 5	6/30/2000	6/29/2000	Aluminum	7429-90-5	1700		ug/L	EPA 200.7	7/17/2000
151244	MP-4 5	6/30/2000	6/29/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Barium	7440-39-3	17		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Cadmium	7440-43-9	23		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Calcium	7440-70-2	440000		ug/L	EPA 200.7	7/13/2000
151244	MP-4 5	6/30/2000	6/29/2000	Chromium	7440-47-3	320		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Cobalt	7440-48-4	800		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Copper	7440-50-8	20U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Iron	7439-89-6	700000		ug/L	EPA 200.7	7/13/2000
151244	MP-4 5	6/30/2000	6/29/2000	Lead	7439-92-1	10		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Magnesium	7439-95-4	280000		ug/L	EPA 200.7	7/13/2000
151244	MP-4 5	6/30/2000	6/29/2000	Manganese	7439-96-5	41000		ug/L	EPA 200.7	7/17/2000
151244	MP-4 5	6/30/2000	6/29/2000	Nickel	7440-02-0	880		ug/L	EPA 200.7	7/17/2000
151244	MP-4 5	6/30/2000	6/29/2000	Potassium	7440-09-7	36000		ug/L	EPA 200.7	7/20/2000
151244	MP-4 5	6/30/2000	6/29/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Sodium	7440-23-5	5100000		ug/L	EPA 200.7	7/27/2000
151244	MP-4 5	6/30/2000	6/29/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Zinc	7440-66-6	1300		ug/L	EPA 200.7	7/13/2000
151244	MP-4 5	6/30/2000	6/29/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151244	MP-4 5	6/30/2000	6/29/2000	Sulfate		11000		mg/L	EPA 300	7/5/2000
151244	MP-4 5	6/30/2000	6/29/2000	Nitrate Nitrogen as N		0.05U		mg/L	LAC107041A	6/30/2000
151244	MP-4 5	6/30/2000	6/29/2000	Ammonia Nitrogen as N		1100		mg/L	LAC107061A	7/11/2000
151244	MP-4 5	6/30/2000	6/29/2000	Chloride		7300		mg/L	LAC117071A	7/3/2000
151244	MP-4 5	6/30/2000	6/29/2000	Bicarbonate Alkalinity		640		mg/L	SM18 2320B	7/6/2000
151244	MP-4 5	6/30/2000	6/29/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151244	MP-4 5	6/30/2000	6/29/2000	Specific Conductivity		272000		umhos/cm	SM18 2510B	7/10/2000
151244	MP-4 5	6/30/2000	6/29/2000	Chromium, hexavalent	18540-29-9	0.058		mg/L	SM18 3500D	6/30/2000
151244	MP-4 5	6/30/2000	6/29/2000	Nitrite Nitrogen as N		0.021		mg/L	SM4500NO2B	6/30/2000
151245	MP-4 3	6/30/2000	6/29/2000	Specific Gravity		1.01			ASTM D1298	7/10/2000
151245	MP-4 3	6/30/2000	6/29/2000	pH		5.97		pH units	EPA 150.1	6/30/2000
151245	MP-4 3	6/30/2000	6/29/2000	Aluminum	7429-90-5	800		ug/L	EPA 200.7	7/17/2000
151245	MP-4 3	6/30/2000	6/29/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Barium	7440-39-3	23		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Cadmium	7440-43-9	10U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Calcium	7440-70-2	480000		ug/L	EPA 200.7	7/13/2000
151245	MP-4 3	6/30/2000	6/29/2000	Chromium	7440-47-3	140		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Cobalt	7440-48-4	170		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Copper	7440-50-8	20U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Iron	7439-89-6	290000		ug/L	EPA 200.7	7/13/2000
151245	MP-4 3	6/30/2000	6/29/2000	Lead	7439-92-1	10U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Magnesium	7439-95-4	280000		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Manganese	7439-96-5	13000		ug/L	EPA 200.7	7/17/2000
151245	MP-4 3	6/30/2000	6/29/2000	Nickel	7440-02-0	220		ug/L	EPA 200.7	7/17/2000
151245	MP-4 3	6/30/2000	6/29/2000	Potassium	7440-09-7	22000		ug/L	EPA 200.7	7/20/2000
151245	MP-4 3	6/30/2000	6/29/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Sodium	7440-23-5	1500000		ug/L	EPA 200.7	7/27/2000
151245	MP-4 3	6/30/2000	6/29/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Zinc	7440-66-6	160		ug/L	EPA 200.7	7/13/2000
151245	MP-4 3	6/30/2000	6/29/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151245	MP-4 3	6/30/2000	6/29/2000	Sulfate		5200		mg/L	EPA 300	7/5/2000
151245	MP-4 3	6/30/2000	6/29/2000	Nitrate Nitrogen as N		0.05U		mg/L	LAC107041A	6/30/2000
151245	MP-4 3	6/30/2000	6/29/2000	Ammonia Nitrogen as N		650		mg/L	LAC107061A	7/11/2000
151245	MP-4 3	6/30/2000	6/29/2000	Chloride		4100		mg/L	LAC117071A	7/3/2000
151245	MP-4 3	6/30/2000	6/29/2000	Bicarbonate Alkalinity		76		mg/L	SM18 2320B	7/6/2000
151245	MP-4 3	6/30/2000	6/29/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151245	MP-4 3	6/30/2000	6/29/2000	Specific Conductivity		13000		umhos/cm	SM18 2510B	7/10/2000
151245	MP-4 3	6/30/2000	6/29/2000	Chromium, hexavalent	18540-29-9	0.005U		mg/L	SM18 3500D	6/30/2000
151245	MP-4 3	6/30/2000	6/29/2000	Nitrite Nitrogen as N		0.01U		mg/L	SM4500NO2B	6/30/2000
151246	MP-4 2	6/30/2000	6/29/2000	Specific Gravity		1.02			ASTM D1298	7/10/2000
151246	MP-4 2	6/30/2000	6/29/2000	pH		6.01		pH units	EPA 150.1	6/30/2000
151246	MP-4 2	6/30/2000	6/29/2000	Aluminum	7429-90-5	3000		ug/L	EPA 200.7	7/17/2000
151246	MP-4 2	6/30/2000	6/29/2000	Antimony	7440-36-0	20U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Arsenic	7440-38-2	10U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Barium	7440-39-3	22		ug/L	EPA 200.7	7/11/2000

Sample Number	Client ID	Date Received	Date Collected	Parameter	CAS Number	Result	Quantitation Limit	Units	Method	Date Analyzed
151246	MP-4 2	6/30/2000	6/29/2000	Beryllium	7440-41-7	2U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Cadmium	7440-43-9	10U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Calcium	7440-70-2	420000		ug/L	EPA 200.7	7/13/2000
151246	MP-4 2	6/30/2000	6/29/2000	Chromium	7440-47-3	380		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Cobalt	7440-48-4	260		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Copper	7440-50-8	21		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Iron	7439-89-6	180000		ug/L	EPA 200.7	7/13/2000
151246	MP-4 2	6/30/2000	6/29/2000	Lead	7439-92-1	10U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Magnesium	7439-95-4	230000		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Manganese	7439-96-5	15000		ug/L	EPA 200.7	7/17/2000
151246	MP-4 2	6/30/2000	6/29/2000	Nickel	7440-02-0	330		ug/L	EPA 200.7	7/17/2000
151246	MP-4 2	6/30/2000	6/29/2000	Potassium	7440-09-7	20000		ug/L	EPA 200.7	7/20/2000
151246	MP-4 2	6/30/2000	6/29/2000	Selenium	7782-49-2	10U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Silver	7440-22-4	10U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Sodium	7440-23-5	2400000		ug/L	EPA 200.7	7/27/2000
151246	MP-4 2	6/30/2000	6/29/2000	Thallium	7440-28-0	10U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Vanadium	7440-62-2	10U		ug/L	EPA 200.7	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Zinc	7440-66-6	440		ug/L	EPA 200.7	7/13/2000
151246	MP-4 2	6/30/2000	6/29/2000	Mercury	7439-97-6	0.2U		ug/L	EPA 245.1	7/7/2000
151246	MP-4 2	6/30/2000	6/29/2000	Sulfate		6400		mg/L	EPA 300	7/5/2000
151246	MP-4 2	6/30/2000	6/29/2000	Nitrate Nitrogen as N		0.05U		mg/L	LAC107041A	6/30/2000
151246	MP-4 2	6/30/2000	6/29/2000	Ammonia Nitrogen as N		2100		mg/L	LAC107061A	7/11/2000
151246	MP-4 2	6/30/2000	6/29/2000	Chloride		4000		mg/L	LAC117071A	7/3/2000
151246	MP-4 2	6/30/2000	6/29/2000	Bicarbonate Alkalinity		200		mg/L	SM18 2320B	7/6/2000
151246	MP-4 2	6/30/2000	6/29/2000	Carbonate Alkalinity		1U		mg/L	SM18 2320B	7/6/2000
151246	MP-4 2	6/30/2000	6/29/2000	Specific Conductivity		151000		umhos/cm	SM18 2510B	7/10/2000
151246	MP-4 2	6/30/2000	6/29/2000	Chromium, hexavalent	18540-29-9	0.010		mg/L	SM18 3500D	6/30/2000
151246	MP-4 2	6/30/2000	6/29/2000	Nitrite Nitrogen as N		0.16		mg/L	SM4500NO2B	6/30/2000